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Geology of

Carbonatite – Alkalic Rock Complexes in Ontario:

Clay–Howells Alkalic Rock Complex

District of Cochrane

Ontario Geological Survey
Study 37

by R. P. Sage

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Foreword

The Clay–Howells Alkalic Rock Complex was examined as part of a project to study alkalic rock – carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne

Director
Ontario Geological Survey

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

Geology of
Carbonatite – Alkalic Rock Complexes in Ontario:
Clay–Howells Alkalic Rock Complex
District of Cochrane

R.P. Sage[1]

1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication by John Wood, Chief Geologist, Ontario Geological Survey, June 1983.

This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Clay–Howells Alkalic Rock Complex occurs within the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. The intrusion is likely a mushroom–shaped body in vertical cross–section. Magma was likely supplied to it by dikes emplaced along faults associated with the Kapuskasing Subprovince.

The complex is composed dominantly of pyroxene syenite. Aeromagnetic patterns suggest that it may be a composite intrusion formed by several magma pulses of similar composition.

The complex has been dated at 1072 ± 16 Ma by Rb–Sr isotopic techniques.

In the southeast corner of the complex, a dike–like carbonatite intrusion has been drilled by Mattagami Mining Company Limited. A deposit of 10 million tonnes of magnetite–bearing material have been outlined, containing anomalous niobium, tin, zinc and molybdenum. The carbonatite appears unrelated to the host pyroxene syenite.

Résumé

Le complexe rocheux alcalin Clay–Howells est situé dans la sous–province de Kapuskasing, dans la province Supérieure du bouclier canadien. Vue en coupe transversale verticale, l'intrusion est probablement en forme de champignon. Du magma se serait introduit par l'entremise de dykes situés le long des failles de la sous–province de Kapuskasing.

Le complexe est essentiellement composé de syénite pyroxène. Les levés aéromagnétiques semblent indiquer qu'il s'agit peut–être d'une intrusion composite formée de plusieurs impulsions de magma de composition semblable.

D'après les techniques isotopiques de datation au Rb–Sr, l'âge du complexe est de 1072 ± 16 Ma.

La Mattagami Mining Company Limited a foré une intrusion carbonatite semblable à un dyke dans la partie sud–est du complexe. On a identifié un dépôt de dix millions de tonnes riche en magnétite et contenant du niobium, de l'étain, du zinc et du molybdène irréguliers. Il semble que la carbonatite soit distincte du syénite pyroxène hôte.

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Introduction

As part of a program to investigate the economic potential of the carbonatite–alkalic rock suite within the Province of Ontario, a mapping program was conducted on the Clay–Howells Alkalic Rock Complex. The Clay–Howells complex is one of a number of alkalic rock intrusions occurring within the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. On the basis of aeromagnetic data and outcrop pattern the complex is estimated to have a surface area of 113 km^2. The complex is Late Precambrian in age and consists of a large, relatively homogeneous intrusion(s) of syenite to monzonite composition. The emplacement of the stock in the gneissic rocks enveloping the complex has caused little disruption in structural trends, implying that the intrusion, in vertical cross–section, is likely mushroom–shaped. Closure of isomagnetic contours on aeromagnetic maps 2286G and 2305G (ODM–GSC 1964a,b) implies that the complex was emplaced as several magmatic pulses, which from field observation and chemical data are similar in texture, mineralogy and composition.

The Clay–Howells complex is fresh, unmetamorphosed and has been emplaced into a gneissic terrain of the Kapuskasing Structural Zone, metamorphosed to upper amphibolite to granulite facies.

A dike–like body of magnetite–rich carbonatite intrudes the syenitic to monzonitic rocks within the southeast corner of the complex. Syenitic rocks bordering the carbonatite have been altered and metasomatized and display granoblastic textures.

Diamond drilling of the carbonatite by Mattagami Mining Company Limited has indicated 10 million tonnes of material containing 10 to 80% magnetite, (Shklanka 1968). Small chip samples made available to the Ministry by Pickands Mather Company of Cleveland, Ohio, have upon spectrographic examination disclosed anomalous contents of niobium, tin, molybdenum and zinc.

ACKNOWLEDGMENTS

The author was assisted by Mr. D. Bathe and Mr. W. Wright during the 1975 field program. Mr. Bathe mapped the north side of the Mattagami River as far south as the Mattagami Mining Company Limited property and then both sides of the Kapuskasing River and Mattagami River until beyond the aeromagnetically indicated south contact of the complex. Mr. Bathe and Mr. Wright ran a number of traverses into the north central interior of the complex. The author mapped the remaining shoreline and completed several traverses from the Kapuskasing River into the complex along its east flank. Mr. P. Chamois and Mr. K. Shewbridge, junior assistants, assisted with the mapping chores. A boat and motor were provided for the crew by the Ministry of Natural Resources personnel in Cochrane.

The author was assisted in additional mapping in 1977 by Mr. S. Wilkinson. Helicopter support was provided by Huissen Aviation, Timmins, Ontario. Mr. D. Arnnete was the pilot.

Room and board for the 1975 field program was provided by the Spruce Falls Pulp and Paper Company at Smoky Falls. Mr. Lyle Atkins, electrical superintendent for Spruce Falls Pulp and Paper Company, Kapuskasing, completed the arrangements for the field party to stay at Smoky Falls. Mr. D. Potvin, Mr. Rich-

ter and Mr. M. Gareau of the Smoky Falls Pulp and Paper Company, assisted the party during the stay.

In 1977, Mr. A. Thom, electrical superintendent for Spruce Falls Pulp and Paper Company, Kapuskasing, completed the arrangements for the party to stay at Smoky Falls. Mr. D. Potvin and Mr. M. Gareau of the Spruce Falls Pulp and Paper Company, supported the field party during the stay at Smoky Falls.

Dr. R.A. Schmidt of the Pickands Mather Company of Cleveland, Ohio, gave permission to examine and sample diamond drill core obtained from their property on the complex and supplied to the Ministry diamond drill logs not submitted for assessment work credit.

Mr. C.A. Krause, exploration manager for Campbell Chibougamau Mines Limited, supplied the Ministry with data that had not been previously submitted for assessment work credit.

Mr. A. Lisowyk recalculated the average chemical compositions of the lithologic units in 1988.

LOCATION AND ACCESS

The Clay–Howells Alkalic Rock Complex (Figure 1) is located at approximately 49°50'N Latitude and 82°05'W Longitude and is crossed by both the Mattagami and Kapuskasing Rivers. Dams constructed by Ontario and Spruce Falls Pulp and Paper Company across the Mattagami River have backed up both of these rivers, flooding the low lying areas along the rivers. The flooding has made areas along the north, east and south sides of the complex easily accessible by boat.

The reservoir, where a boat may be launched and access gained to the complex, is approximately 130 km from Smooth Rock Falls, via Highway 805 to Fraserdale where a gravel road leads northwest to the dam site. From the boat landing on the Mattagami River, the northern contact of the complex lies 10 km to the south. Most of the outcrop within the complex lies in the northeast corner of the complex. Interior areas of the complex are reasonably accessible only by helicopter.

FIELD METHODS

In 1975 most of the outcrop within 3 km of the Kapuskasing and Mattagami Rivers was mapped by ground traversing. In 1977, most of the isolated, remaining outcrops within traversing distance of the river system which were missed in the 1975 program were examined and 3 days of helicopter mapping completed. During 1975 a total of 19 man days and in 1977 a total of 10 man days were spent mapping the intrusion.

Mapping of the complex was by pace–and–compass techniques. Outcrops encountered on traverse were noted on acetate overlays of 1:15,840 scale airphotos supplied by the Airphoto Library, Ontario Ministry of Natural Resources. Outcrop data were transferred from the acetate overlays to a cronoflex at the same scale supplied by the Cartography Section of the Ontario Ministry of Natural Resources. Outcrops indicated to be present on the basis of airphoto interpretation but not visited were added to the cronoflex base and coded for rock type as interpreted from the aeromagnetic data.

Data obtained from the Assessment Files Research Office, Ontario Geological Survey was added to the cronoflex base.

Outcrop classification was modified after thin section examination of a selected group of samples.

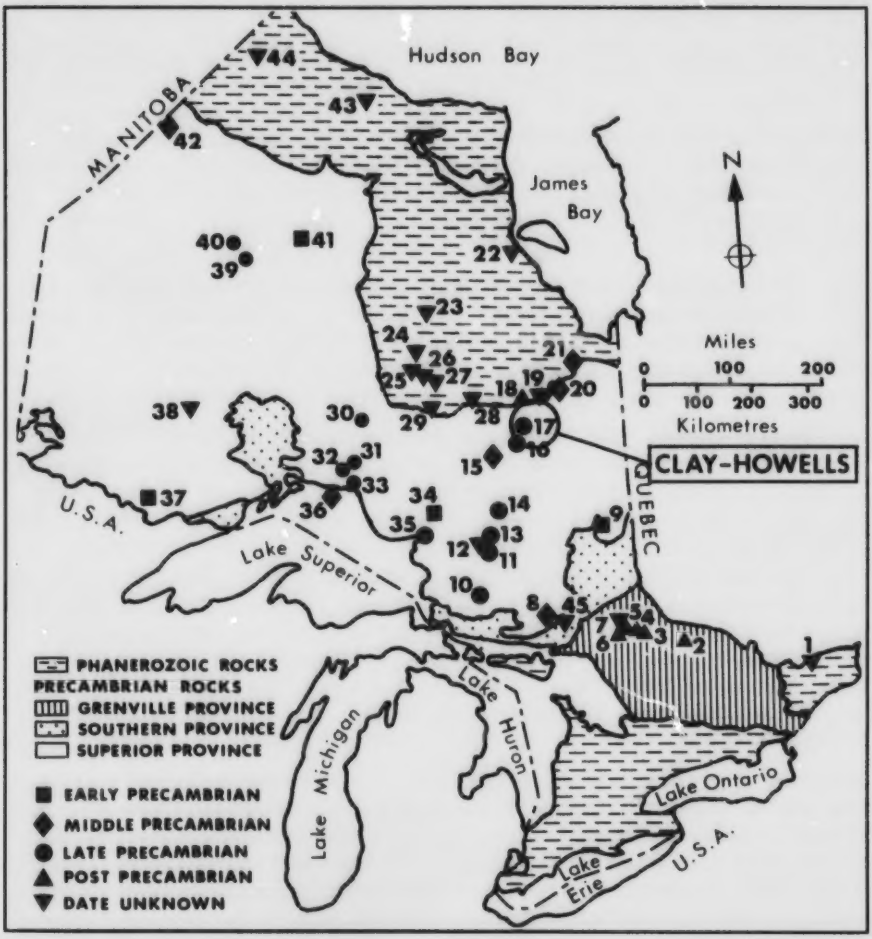

Figure 1. *Key map showing location of carbonatite – alkalic rock complexes in Ontario.*

1. *Eastview*
2. *Brent*
3. *Callander B.*
4. *Manitou Is.*
5. *Burritt Is.*
6. *Iron Is.*
7. *Lavergne*
8. *Spanish R.*
9. *Otto Stock*
10. *Seabrook L.*
11. *Lackner L.*
12. *Borden Tp.*
13. *Nemegosenda L.*
14. *Shenango Tp.*
15. *Cargill Tp.*
16. *Teetzel Tp.*
17. **Clay-Howells**
18. *Hecla-Kilmer*
19. *Valentine Tp.*
20. *Goldray*
21. *Argor*
22. *Lawashi R.*
23. *Poplar R.*
24. *Albany Forks*
25. *L. Drowning R.*
26. *Kingfisher R. West*
27. *Kingfisher R. East*
28. *Martison L.*
29. *Nagagami R.*
30. *Chipman L. (dikes)*
31. *Killala L.*
32. *Prairie L.*
33. *Port Coldwell*
34. *Herman L.*
35. *Firesand R.*
36. *Slate Is.*
37. *Poohbah L.*
38. *Sturgeon Narrows & Squaw L.*
39. *Schryburt L.*
40. *Big Beaver House*
41. *Wapikopa L.*
42. *"Carb" L.*
43. *Gooseberry Br.*
44. *Niskibi L.*
45. *Nemag L. & Lusk L.*

PREVIOUS GEOLOGICAL WORK

The first published work on the complex was by Bennett *et al.* (1967a) who completed reconnaissance mapping of the complex and surrounding area. Gittins *et al.* (1967) obtained a K–Ar isotopic age of 1010 Ma on rocks from the complex. P. Chamois (1977) completed a B.Sc. thesis on the complex. Bell and Blenkinsop (1980) reported an Rb/Sr age of 1072 ± 16 Ma from syenite samples collected from the complex during this survey.

PHYSIOGRAPHY

Outcrops are low and rounded, widely spaced, and separated by extensive areas of low swampy ground. Large areas of the complex in the west and south have no outcrop and are covered by swamp. Most outcrops within the northeast corner lie within 3.2 km of the Mattagami River and can be reached by normal ground traversing.

The topographic relief on the complex is estimated to generally not exceed 7.5 m, however within the centre of the intrusion ridges of outcrop may rise about 20 to 30 m.

LABORATORY TECHNIQUES

A group of samples were selected for thin sectioning. A selected group of fresh, homogeneous, and generally equigranular syenite to monzonite rocks were submitted for complete rock analysis. A selected suite of core samples provided by the Pickands Mather Company were also thin sectioned and chemically analyzed.

NOMENCLATURE

Nomenclature used in mapping alkalic rock – carbonatites of Ontario is modified after that of Parsons (1961). The author has used a somewhat different nomenclature in the present report, in conformity with the nomenclature used in describing other alkalic rock – carbonatite complexes in northern Ontario. For the alkalic rocks, the author prefers to use mineralogic, colour, or textural modifiers, which are familiar to all readers, rather than unfamiliar rock names. Alkalic rock nomenclature is cumbersome, due in large part to the profusion of unfamiliar rock names. Consequently, as an aid to the reader, the use of less familiar rock names will be limited. The rock terms retained by the author and the way they are used are given below.

Ijolite. A nepheline–pyroxene rock with a nepheline content between 30 and 70%. Rocks containing more than 70% nepheline are classified as urtite and those with less than 30% as melteigite. Some specimens may contain significant amounts of biotite in place of pyroxene. Potassium feldspar content is 10% or less and those rocks with 10% or less nepheline are classified as pyroxenite.

Malignite. A melanocratic nepheline syenite. In general, nepheline, pyroxene and potassium feldspar occur in roughly equal proportions. The potassium feldspar content must exceed 10% or the rock is classified as belonging to the ijolite suite. Both the nepheline and pyroxene content must exceed 10% or the rock would be classified with the syenites. This rock group is transitional between the ijolites and overlaps the syenitic rock groups.

Sovite. A carbonatite rock composed of 50% or more calcite. Various mineralogic modifiers are used to classify the sovite, for example, apatite–magnetite sovite, olivine–amphibole sovite, etc.

Silicocarbonatite. A carbonate–rich rock containing 50% or more oxide and silicate minerals. Where the silicate or oxide minerals make up more than 90% of the rock, various other rock names are applied; i.e. ijolite, biotite, pyroxenite, etc.

Syenite. This term is restricted to a quartz–free rock consisting primarily of alkali feldspars. Various mafic minerals and nepheline may be present and form a significant component of the rock. The syenites are named on the basis of their mineralogy, i.e., pyroxene–nepheline syenite, biotite–amphibole syenite, etc. The syenites are gradational into malignites.

There is no standard subdivision of the ijolite suite into ijolite, urtite, and melteigite. Bailey (1974, p.53) classified urtites as having more than 70% nepheline, however he used the term ijolite to apply only to those rocks containing between 50 and 70% nepheline. The author finds this range to be too restricted for field use and prefers the 30 to 70% range given by Williams *et al.* (1954, p.70).

Malignite from the Poohbah Lake Complex in northwestern Ontario was originally defined by Lawson (1896) as an alkali–rich rock containing pyroxene, and potassium feldspar, with or without nepheline, garnet and amphibole. The author has examined the malignite of this complex in the field and in a large number of thin sections. The malignites are melanocratic and contain pyroxene, nepheline, orthoclase, garnet, and amphibole. The nepheline content of the type location is relatively low compared with the definition given above. For field work and to better emphasize the gradational nature of malignite into ijolites and syenites without the use of cumbersome terminology, a broader usage of the term has been applied by the author. Williams *et al.* (1954, p.65–66)described a number of malignites of varying mineralogy.

The Poohbah Lake type location for malignite was re–investigated by Mitchell and Platt (1978) and malignite was redefined by them as a nepheline syenite containing oikocrystic potassium feldspar. The author considers the definition of Mitchell and Platt too restrictive. The term malignite is used by the author for a melanocratic nepheline syenite as defined by Sorensen (1974, p.27).

The definitions of sovite and silicocarbonatite are modified from Heinrich (1966, p.12). The author has found Heinrich's subdivision of the carbonate–rich carbonatitic rocks generally suitable for field usage when modified to a two–fold subdivision at about 50% oxide and silicate mineral contents. The two–fold subdivision is more convenient than the four–fold subdivision of Heinrich (1966) because carbonatites show extreme variations in mineral content over distances of less than a few centimetres. It is difficult to rigorously classify such heterogeneous rocks.

General Geology

The syenitic rocks of the Clay–Howells Alkalic Rock Complex (Table 1, Figure 2 and Figure 3, Chart A, back pocket) appear to intrude a sequence of paragneisses and orthogneisses that have been regionally metamorphosed to the upper amphibolite to possibly the granulite facies rank. Rocks of this relatively high metamorphic rank are characteristic of the Kapuskasing Subprovince within which this complex lies. The general shape of the complex is well illustrated by the aeromagnetic map (Figure 2). Closure of isomagnetic contours on the aeromagnetic maps implies that the complex may have formed by emplacement of several pulses of syenitic magma.

Two broad classes of syenitic rocks were noted. The most common, and centrally located, syenite is generally coarse–grained, deeply weathered, and when fresh samples can be obtained, it is grey–green to green in colour. Along the contact of the syenite and wall rock, a second class of syenite is red–brown in colour, highly variable in texture, and commonly xenolithic (Photo 1). This variability in texture is restricted to the contact zone. The biotite content appears to increase towards the centre of the body.

Mapping so far has failed to disclose silica–undersaturated syenitic rocks or rocks of the ijolitic suite. The syenites examined appear to be more closely analogous to some of those at the Port Coldwell Alkalic Rock Complex or perhaps the more central portions of the Killala Lake Alkalic Rock Complex; neither of these complexes contain carbonatite (Sage 1987, 1988b).

The alkalic rock complexes at Nemegosenda Lake and Lackner Lake, which contain minor amounts of carbonatite, have silica–undersaturated syenitic rocks and rocks of the ijolitic suite (Parsons 1961, Sage 1987, 1988b). In addition, the paragneissic and amphibolitic wall rocks lack any evidence of fenitization which is characteristic of carbonatite intrusions. If the present observations hold true, the syenitic rocks found within the complex and the magnetite–bearing carbonatite drilled by Mattagami Mining Company Limited in the southeast corner of the complex are possibly two distinctly different and perhaps unrelated alkalic intrusions. In thin section, the syenitic rocks bordering this carbonatite are metasomatized and exhibit granoblastic (hornfels) textures.

Shklanka (1968) reported that this carbonatite unit contains 10 million tonnes of material ranging from 10 to 80% magnetite.

EARLY PRECAMBRIAN (ARCHEAN)

The Early Precambrian rocks consist of a suite of gneissic rocks metamorphosed from the upper amphibolite to possibly the lower granulite facies rank of regional metamorphism. These gneissic rocks were subsequently intruded by various granitic rocks. The best exposure of the gneissic rocks is along the Kapuskasing and Mattagami Rivers east and south of Devils Rapids at the northeast corner of the complex.

GNEISSIC ROCKS

The gneissic rocks are characterized by a distinct or diffuse banding due to variation in the relative proportions of light– and dark–coloured minerals. Banding is on the order of a few centimetres, only rarely approaching 0.3 m. The gneisses

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE CLAY-HOWELLS ALKALIC ROCK COMPLEX.

CENOZOIC

QUATERNARY

Recent and Pleistocene

Stream, lake, and swamp deposits; glacial deposits.

Unconformity

LATE PRECAMBRIAN (PROTEROZOIC)

CLAY-HOWELLS ALKALIC ROCK COMPLEX

Dike Rocks*

Amphibole syenite, generally with trachytoid texture; melanocratic amphibole-pyroxene-oligoclase syenite.

Intrusive Contact

Carbonatite†

Silicocarbonatite (biotite-magnetite-carbonate-aegirine-augite-apatite rock); carbonatite; magnetite-rich rock.

Intrusive & Gradational Contacts

Syenite Contact Rocks†

Mafic biotite-amphibole-pyroxene syenite; granoblastic aegirine-augite syenite; fine-grained syenite with dark mafic veins; alkalic granite, probably dikes.

Gradational Contact

Syenitic Rocks

Green, olivine-bearing, biotite-amphibole, pyroxene syenite; brown olivine-bearing, biotite-amphibole (hornblende)-pyroxene syenite; biotite-clinopyroxene-amphibole granite; fine-grained olivine-bearing, biotite-amphibole-pyroxene syenite; inhomogeneous syenite, aplitic fracture fillings; red-brown, amphibole-pyroxene-biotite syenite; biotite gabbro.

Intrusive Contact

MIDDLE PRECAMBRIAN (PROTEROZOIC)

MAFIC INTRUSIVE ROCKS

Diabase; pyroxene-porphyritic diabase; feldspar-porphyritic diabase.

Intrusive Contact

EARLY PRECAMBRIAN (ARCHEAN)

LATE FELSIC INTRUSIVE ROCKS*

Granite to quartz monzonite dikes; granitic pegmatite.

Intrusive Contact

MAFIC INTRUSIVE ROCKS*

Metagabbro; porphyritic metagabbro dike.

Intrusive Contact (?)

FELSIC INTRUSIVE ROCKS*

Trondhjemite to granodiorite (?) dikes.

Intrusive Contact

GNEISSIC ROCKS

Garnet-biotite-clinopyroxene-amphibole-quartz-feldspar paragneiss; biotite-clinopyroxene-quartz-feldspar orthogneiss; amphibolite.

NOTES

*Age relationships difficult to establish.

†These rocks do not outcrop, but were intersected in drillholes of Pickands Mather Co.

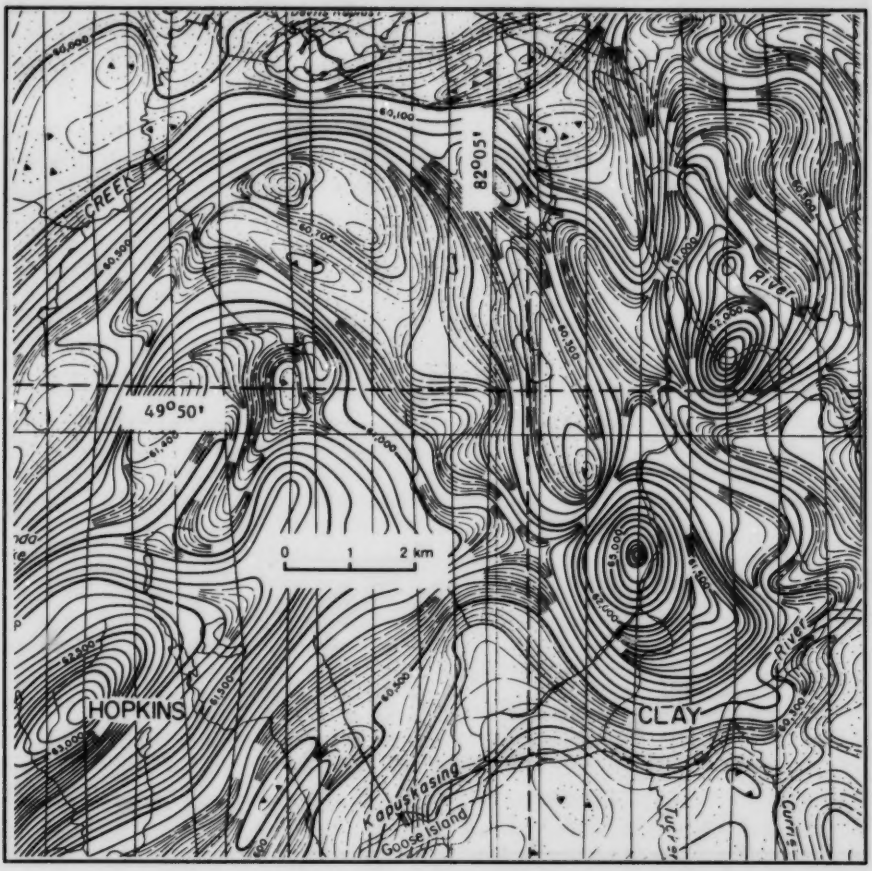

Figure 2. *Aeromagnetic map of the Clay-Howells Alkalic Rock Complex (from Aeromagnetic Maps 2286G and 2305, ODM-GSC 1964a,b).*

weather grey, grey-brown and brown and on fresh surface are generally grey. The grain size varies from fine to medium. The distinction in the field between paragneiss and orthogneiss was made on the presence or absence respectively, of red garnet. In all probability more extensive thin section examination might indicate that the two rock types are gradational into each other and are largely orthogneiss.

Paragneiss

In thin section, the paragneiss (unit 1a) is fine to medium grained, equigranular, allotriomorphic, granoblastic, with curved to straight grain boundaries. On the basis of a very limited number of thin sections, it is estimated to contain 5 to 30% garnet, 5 to 25% clinopyroxene, 5 to 15% quartz, 0 to 5% amphibole, 35 to 55% plagioclase (An 44–56), and 0 to 20% biotite. Trace amounts of magnetite, epidote and fibrous amphibole are present.

The garnet is anhedral to subhedral in form and may poikilitically contain grains of plagioclase, pyroxene, magnetite and biotite. The garnet is fractured and, in one case, fine-grained sericite occurs along the fractures. Chamois

(1977) has also found quartz poikilitically enclosed within the garnet and identified a chloritic alteration of the garnet. In thin section the garnet tends to be porphyroblastic.

The clinopyroxene is colourless and occurs in anhedral, somewhat rounded, equant grains. Incipient alteration to epidote(?) and actinolite–tremolite(?) occurs along the edges of the crystals. The pyroxene grains may occur as isolated crystals or as clots of several grains. Quartz occurs as a mosaic of anhedral grains interlocking with plagioclase. The quartz may have a wavy extinction. The amphibole is pleochroic in green–brown and commonly mantles pyroxene. The amphibole occurs in somewhat elongated grains. The plagioclase (An 44–56) forms a mosaic of anhedral grains interlocking with the quartz. Minor saussuritization of the plagioclase is present along fracture and cleavage planes and several of the larger grains display bent (010) twin planes. The bent twin planes indicate the development of a weak protoclastic texture.

Biotite forms pleochroic, yellow–brown to brown, ragged, tabular grains. The grains generally display a preferred orientation of the (001) cleavage that defines a weak schistosity. The biotite is closely associated with the other mafic constituents and may in part result from the alteration of these other minerals.

Orthogneiss

On the basis of a very limited number of thin sections the orthogneiss (unit 1b) is fine to medium grained, equigranular, allotriomorphic, granoblastic, with curved to straight grain boundaries. In thin section the rock is estimated to contain 0 to 40% clinopyroxene, 0 to 20% biotite, 10 to 30% quartz and 45 to 60% plagioclase (An 33–50). Trace to minor amounts of magnetite and garnet are present. Chamois (1977) reported potassium feldspar in the orthogneiss but this was not observed by the author.

Photo 1. ***Xenoliths of amphibolite or an earlier phase of the syenite complex within pyroxene–amphibole syenite.***

The clinopyroxene may be mantled with green amphibole and brown biotite or it may be mantled with a very fine–grained mixture of fibrous amphibole(?) and epidote.

The biotite forms tabular, pleochroic, brown, anhedral grains. The biotite occurs closely associated with the pyroxene and may in part have formed by the breakdown of the pyroxene. Kinking and bending of the (001) cleavage, present in two samples, indicates the development of a weak protoclastic texture. A preferred orientation of the (001) cleavage may impart a weak schistosity to the rock. The quartz forms an anhedral, interlocking mosaic with plagioclase. The quartz displays a wavy extinction.

The plagioclase (An 33–50) forms an anhedral, interlocking mosaic with quartz. Some saussuritization of the plagioclase has occurred along fractures, cleavages or grain boundaries. Bending of the (010) twin plane on some of the larger grains indicates the development of a weak protoclastic texture.

Trace amounts of magnetite are commonly mantled with biotite.

Amphibolite

Amphibolite of uncertain original form or genesis occurs as a minor component within the gneissic terrain. The amphibolite (unit 1c) forms concordant bands within the gneisses. On weathered surface the amphibolite bands weather brown, grey, black, green–black and brown–black.

Because of the limited importance of the amphibolite only one thin section was prepared from a xenolith within the syenite complex.

In thin section the rock is medium grained, equigranular, massive, allotriomorphic–granoblastic, with curved to straight grain bundaries. The mode is estimated to be 20% clinopyroxene, 25% dark green–brown amphibole, and 55% plagioclase (An 52–57). Trace amounts of magnetite and olivine are present.

The pyroxene is colourless, anhedral, and thickly mantled with amphibole. The amphibole is pleochroic in dark green–brown and appears to be an alteration after pyroxene. The plagioclase is anhedral in shape and forms an interlocking mosaic of grains with a granoblastic appearance.

Trace amounts of olivine occur as rounded, anhedral grains in association with pyroxene and both are mantled with amphibole and traces of biotite. The olivine has a yellow–brown alteration along fractures that is in part composed of iddingsite.

Texturally and compositionally, the xenolith appears to be a metagabbro or mafic metavolcanic. Because the sample is likely a product of both metasomatism and contact metamorphism, the present mineralogy and texture are unlikely to represent original mineralogy and texture. Textures likely to be more representative of this unit are discussed under "Mafic Intrusive Rocks".

FELSIC INTRUSIVE ROCKS

Intruding the gneissic rocks are a series of concordant to discordant granitic dikes. The rocks range from fine grained to coarse grained to pegmatitic, and weather buff to pale pink. While they clearly cut the gneisses and amphibolite, the relationship between these granitic rocks and the metagabbro (unit 3) is unclear. On the basis of limited field observations the granitic rocks of this map unit do not appear to extensively cut the metagabbro.

In thin section the rock is fine to medium grained, massive, equigranular, allotriomorphic, granoblastic, with straight to lobate grain boundaries. On the

basis of two thin sections, the mode is estimated to be 30% quartz, 50% altered plagioclase (An 38?) and 20% altered potassium feldspar(?). Trace amounts of fine-grained aggregates of sericite, chlorite, epidote and biotite are present.

The quartz forms anhedral grains with lobate grain boundaries. It is the only fresh unaltered mineral in the samples examined. The plagioclase forms anhedral turbid grains interlocked with the quartz. Ghosts of albite twinning are present in some grains. The turbid nature of the grains is due to widespread, pervasive, saussuritization of the feldspar. Some of these grains are likely potassium feldspar but their alteration is too intense to allow for positive identification.

The fine-grained masses of biotite, epidote, sericite and chlorite are likely the alteration products of an unidentifiable mafic mineral.

These rocks are classified as altered trondhjemite to perhaps granodiorite.

MAFIC INTRUSIVE ROCKS

Relatively massive units of amphibolite, generally gneissic, occur as concordant bodies within the feldspathic gneisses along the Mattagami River east of Devils Rapids. These bodies have been interpreted to be representative of former mafic intrusive rocks. Some of the units contain abundant red garnet up to 1 cm in diameter. Garnet and amphibole-pyroxene may be concentrated into more or less distinct bands. Banding on the order of 15 cm in width is present and isolated green pyroxene grains rimmed with dark green amphibole up to 1.5 cm are rarely found in outcrop at the constriction in the Mattagami River approximately 1.6 km east of Devils Rapids. Some outcrops are cut by stringy veinlets of quartz.

The rocks weather black and green-black to mottled buff and green-black. The lighter coloured rocks are representative of the more plagioclase-rich phases. Similar colours are present on the fresh surface.

In thin section the rock is fine to medium grained, massive, equigranular, allotriomorphic-granoblastic, with curved to straight grain boundaries.

The mode, based on 3 thin sections, is estimated to be 5 to 10% clinopyroxene, 20 to 50% amphibole and 44 to 60% plagioclase (An 43-60). Minor magnetite and apatite occur as accessories. While garnet was not observed in the 3 thin sections examined, it occurs as bright red anhedral grains in outcrop and locally is estimated to constiute 10 to 15% of the rock. One thin section contains up to 10% biotite as well as a minor amount of a fine-grained mixture of chlorite and biotite.

The clinopyroxene is colourless and occurs as anhedral, equant grains thickly mantled with amphibole. Some grains also display alteration to a fine-grained mixture of fibrous amphibole and opaques. The very fine-grained mixture of chlorite and biotite observed in one thin section is most likely an alteration of pyroxene or amphibole.

Amphibole occurs as dark green-brown, anhedral grains commonly mantling or containing relict clinopyroxene cores. The amphibole forms a interlocking mosaic with plagioclase. A relatively high percentage of the amphibole appears to have replaced pyroxene. In outcrop the amphibole appears to occur as elongate, more or less acicular grains; however in thin section the elongate nature is not apparent.

The plagioclase (An 45-60) occurs as anhedral grains forming an interlocking mosaic with the amphibole-pyroxene. The plagioclase is fresh and appears locally to have been fractured and deformed.

The metagabbro displays the effects of retrograde metamorphism. It is uncertain as to whether this is representative of regional metamorphism or the result of contact–metasomatic effects resulting from the emplacement of the Clay–Howells complex. The texture of the metagabbro is similar to that of the amphibolite.

LATE FELSIC INTRUSIVE ROCKS

Fine– to coarse–grained granitic dikes clearly cut the gneisses, amphibolite, felsic intrusive rocks and metagabbro. Rocks of this group occur only as minor dikes and represent a more potassium–rich phase of felsic magmatism.

In outcrop the dikes of this group are leucocratic and pink to pale red on fresh and weathered surfaces.

Only one thin section was prepared from this unit and its texture is medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. The mode is estimated to be 35% quartz and 65% perthite.

The quartz forms anhedral, irregular grains interlocked with perthite, creating a mosaic pattern. The perthite is a subsolvus, string perthite with some Carlsbad twinning. The presence of a well developed string perthite texture implies that the rock is relatively unmetamorphosed. The relatively unmetamorphosed nature of the granitic rocks of this map unit contrasts sharply with the older metamorphosed granites (unit 2).

MIDDLE PRECAMBRIAN (PROTEROZOIC)

MAFIC INTRUSIVE ROCKS

Middle Precambrian rocks are restricted to dike rocks cutting the older units. It is on the basis of field relations that this unit is considered to be significantly younger than the gneissic rocks. Rocks of this subdivision have not been observed to cut the Late Precambrian syenite rocks of the Clay–Howells complex. Fine–grained, massive, equigranular to porphyritic rocks originally mapped as lamprophyres by this party have upon thin section examination been reclassified as diabase. Three types of diabase are recognizable in thin section: massive equigranular, homogeneous diabase (unit 5a); feldspar–porphyritic diabase (unit 5c); and pyroxene–porphyritic diabase (unit 5b). The diabase dikes all generally trend north. Cross–cutting relations between the dikes were not observed.

Equigranular Diabase

The best exposure of a homogeneous, equigranular diabase dike (unit 5a) occurs on a small island at Devils Rapids where a north striking dike approximately 20 m wide cutting metagabbro and feldspathic gneisses is exposed. The west contact dips 75 west and the east contact is vertical. The dike is black on weathered and fresh surfaces and displays fine–grained chilled contacts on the order of 15 to 20 cm width.

In thin section the rock is fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The mode is estimated to be 15% clinopyroxene, 25% amphibole, 5% biotite, 5% quartz and 50% plagioclase (An 48–55). The clinopyroxene is turbid and thickly mantled with amphibole and very minor biotite. The pyroxene has undergone considerable alteration.

The amphibole is a dark, green–brown, pleochroic mineral and likely formed by alteration of the pyroxene. The biotite is present in only minor amounts in

association with amphibole and pyroxene of which it is likely an alteration product.

Minor, anhedral, interstitial quartz is present. Some of the quartz may have in part formed by the breakdown of the primary minerals of the diabase.

The plagioclase forms tabular, anhedral crystals interlocked with each other and the altered pyroxene. The plagioclase is fresh, contrasting sharply with the associated altered pyroxene.

Minor magnetite is present and occurs in association with biotite and amphibole implying that it also formed by the breakdown of the pyroxene.

Pyroxene-Porphyritic Diabase

Several porphyritic dike rocks (unit 5b) occur on the shore of some small islands within the Mattagami River, east and southeast of Devils Rapids and may also occur on the shore of the river at Devils Rapids. These dikes have a maximum width of 2 m and a strike generally just a little north of west. The dikes dip vertically to steeply south. Dikes of this group weather subdued and display chilled margins up to 1 or 2 cm in width. The surface is deeply pitted and these pits may reach a diameter of 1 cm. Phenocrysts of green pyroxene and dark green–black amphibole are visible on the weathered surface. Some phenocrysts of possible olivine with dark green–black 0.5 mm reaction rims were also noted. Phenocrysts make up a visually estimated 15 to 20 volume percent of these dikes. The dikes are black to green–black on both fresh and weathered surfaces.

Two thin sections were prepared from this lithologic unit. In thin section, the texture is fine to medium grained, massive, inequigranular–porphyritic–seriate, hypidiomorphic. The groundmass tends to be allotriomorphic–granoblastic, with serrate to lobate grain boundaries. The mode is estimated to be 15 to 20% clinopyroxene phenocrysts, 25 to 35% groundmass pyroxene and amphibole, and 35 to 60% plagioclase (An 46–48?). The phenocrysts are clinopyroxene of anhedral form whose margins have undergone extensive alteration to amphibole. Patchy alteration of the pyroxene to amphibole is also present. The pyroxene of the groundmass appears similar to that of the phenocrysts and has undergone extensive alteration to amphibole. The pyroxene of the groundmass encloses plagioclase grains and occurs as relicts within larger grains of amphibole. The amphibole is a pleochroic green–brown and displays lobate to interdigitating grain boundaries between adjacent grains and plagioclase. The amphibole was formed by the breakdown of the pyroxene, either of the matrix or groundmass. The replacement of the pyroxene by the amphibole imparts a sieve or worm–eaten texture to the pyroxene.

Minor amounts of tabular brown biotite may be present as isolated clots in association with the amphibole. The plagioclase forms tabular–shaped grains with curved to straight grain boundaries to irregularly shaped grains with lobate grain boundaries. The irregularly shaped grains appear to result from metamorphic recrystallization. A relict diabasic texture is present in one of the two thin sections.

Minor magnetite and possibly some epidote occur as alteration products of the pyroxene.

Feldspar-Porphyritic Diabase

Feldspar–porphyritic diabase dikes (unit 5c) are not common within the map–area; they have a northeast strike, dip steeply southeast, and are on the order of 60 to 70 cm wide. Dikes of this map unit are present on the south shore of a small

island approximately 0.8 km southeast of Devils Rapids. Of the two dikes observed only one was studied in thin section. The feldspar phenocrysts are light apple green in colour, comprise up to 20 volume percent of the dike rock, reach a maximum size of 1 cm, and may occur in glomeroporphyritic clusters up to 2.5 cm in diameter. The weathered surface contains pits up to 5 mm in diameter. The mineral that weathers out to form the pits is unknown but it is expected to be a mafic phenocryst that has been altered to chlorite and tremolite–actinolite. The feldspar phenocrysts display well developed concentric zoning on the weathered surface and appear seriate with each other and hiatal with the groundmass. Chilling of the diabase over a width of several centimetres occurs along the contact of the dike(s) with wall rock. The dike is mottled green and black.

In thin section the rock is fine to coarse grained massive, inequigranular–porphyritic–seriate, hypidiomorphic. The rock is estimated to contain the following minerals: biotite 15%, amphibole 30%, plagioclase phenocrysts (An 54) 20%, plagioclase groundmass (An 42) 25%. Minor epidote, magnetite, chlorite and tremolite–actinolite are present and make up the remaining 10%.

The biotite forms pleochroic brown, anhedral, irregular shaped grains interlocked with amphibole. The amphibole is brown to green–brown, pleochroic, and forms irregularly shaped grains interlocked with biotite. Minor, anhedral, disseminated magnetite occurs in association with the biotite and amphibole. The biotite, amphibole and magnetite are likely the result of the breakdown of a former clinopyroxene that was present in a subophitic texture with the plagioclase.

The plagioclase phenocrysts are subhedral to euhedral in form and often display well developed concentric zoning and fracturing. Plagioclase of the matrix is anhedral to subhedral in outline and tabular in form. The plagioclase is fresh in contrast to the extensive alteration of the mafic component.

Aggregates of fibrous amphibole and chlorite likely formed by breakdown of a former mafic phenocryst. The pitted weathered surface may result from the weathering out of these aggregates of alteration minerals.

A small stringer of quartz cuts through the thin section studied.

Xenolithic Diabase

Within the north central area of the Clay–Howells Alkalic Rock Complex containing fine–grained angular mafic inclusions, several outcrops of syenite were interpreted by the author to be diabase xenoliths. The inclusions are grey–black to black on fresh and weathered surface and display sharp contacts with the enclosing syenite.

In thin section the rocks are fine–grained, massive, equigranular, hypidiomorphic–subophitic. The mode is estimated to be 15 to 20% biotite, 15 to 20% pyroxene, 0 to 15% amphibole and 50 to 55% plagioclase (An 58–69). Minor chlorite, magnetite, apatite and olivine are also present.

The biotite occurs as tabular, ragged, pleochroic brown grains and in some instances formed by the breakdown of pyroxene. Apatite and magnetite occur poikilitically enclosed within the biotite.

The pyroxene forms colourless, anhedral grains interstitial to the plagioclase. The pyroxene has altered to amphibole and biotite and often occurs as relict cores mantled by these two minerals.

The amphibole is a dark brown to green–brown pleochroic mineral thickly mantling and replacing pyroxene in an irregular spotty fashion along cleavages and fractures.

Minor olivine displays narrow rims of talc and chlorite alteration.

While these xenoliths are coded as diabase, the exposure occurs immediately south of several outcrops of gabbro (unit 6n). It is thus a possibility that these inclusions represent a fine-grained phase of the gabbro. The presence of minor olivine within the inclusions implies that they are possibly unrelated to the non-olivine bearing diabase dikes found along the Mattagami River on the north flank of the complex.

LATE PRECAMBRIAN (PROTEROZOIC) CLAY-HOWELLS ALKALIC ROCK COMPLEX

The Clay-Howells Alkalic Rock Complex has been isotopically dated by Gittins *et al.* (1967) using K-Ar isotopic techniques at 1010 Ma and by Bell and Blenkinsop (1980) using rubidium-strontium isotopes at 1072 ± 16 Ma. Compared with other alkalic rock complexes found within the Province of Ontario, the intrusion is atypical in having a relatively uniform rock composition.

On the accompanying geologic map (Figure 3, Chart A) the complex has been divided into subcomplexes on the basis of isomagnetic contours (ODM-GSC 1964a,b) rather than lithology. Isomagnetic contours indicate several circular patterns, undoubtedly reflecting subtle variations in accessory magnetite content. The author has interpreted these circular patterns to be due to emplacement of the complex by several magmatic pulses of compositionally similar pyroxene syenite magma. The presence of aegirine in the syenite at the Mattagami Mining Company magnetite occurrence is interpreted by the author to be the product of sodium-iron metasomatism accompanying emplacement of the magnetite-bearing carbonatite and not to represent the emplacement of a separate aegirine-bearing body.

The various map units are discussed in a sequence thought to be oldest to youngest. In addition, petrographic examination of numerous thin sections indicates that the various map units are gradational into each other.

SYENITIC ROCKS

Biotite Gabbro

Several outcrops of gabbroic rocks (unit 6n) occur in the north-central portion of the complex. The outcrops are isolated and their relationship to the syenite is unclear. One outcrop is clearly cut by coarse-grained, red-brown syenite and thus the emplacement of the gabbroic rocks is thought to have preceded the syenite. The location of the outcrops is in the area of closure of isomagnetic contours (ODM-GSC 1964a,b). It is probable that the gabbro represents a dismembered ring or arcuate mass possibly related to one of the suggested subcomplexes.

The rock is grey on fresh and weathered surfaces. The rock is massive, homogeneous, equigranular and medium grained. In thin section the rock is medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries, or hypidiomorphic subophitic.

The mode is estimated to be 45 to 55% plagioclase (An 48-54), 10% biotite, 1 to 5% magnetite, 30 to 40% clinopyroxene and 0 to 5% olivine.

The plagioclase forms tabular, clear grains and bending of the albite twin planes implies the presence of a protoclastic texture.

The pyroxene is an anhedral clinopyroxene, colourless, interstitial to plagioclase. It may display a spotty alteration to biotite.

The biotite forms tabular, anhedral grains with bent (001) cleavage. The biotite may poikilitically enclose pyroxene, plagioclase and olivine. Minor anhedral magnetite may be associated with the biotite.

The minor magnetite present, in addition to that associated with biotite, is anhedral and disseminated throughout.

Olivine was not present in all thin sections but where present it is closely associated with clinopyroxene. The olivine may display alteration to iddingsite and to a brown, unidentified, turbid alteration along curved fractures.

The gabbro is classified as a biotite gabbro or olivine–bearing biotite gabbro.

Green Pyroxene Syenite

The dominant rock type, if not essentially the exclusive syenite rock of the complex, is olivine–bearing, biotite–amphibole, pyroxene syenite (unit 6a). This rock type is medium to coarse–grained, massive and equigranular. The rock weathers buff, pink–brown, brown, rusty brown and on the outcrop surface the rock is crumbly and has a thick weathering rind. On fresh surface rocks of this group are grey, grey–green to green.

In thin section, rocks of this group generally are medium to coarse grained, massive, equigranular to inequigranular–seriate, allotriomorphic, with lobate grain boundaries. The mode of this rock is estimated to be 0 to 5% olivine, 0 to 10% biotite, 0 to 1% apatite, 0 to 25% pyroxene, trace to 5% magnetite, 0 to 42% plagioclase (An 26–34), 0 to 25% amphibole and 50 to 78% perthite. Quartz, actinolite, sphene, zircon and myrmekite are present in a number of thin sections.

The olivine occurs as rounded to irregular grains in close association with the pyroxene. The olivine is commonly altered to a red–brown iddingsite and where fresh grains are present a dusty brown alteration occurs along curved fractures. In rare instances some very fine–grained green amphibole may be present as an alteration of the olivine. Chamois (1977 p.25) also reported chlorophaeite as an alteration product of olivine. Olivine was noted to poikilitically contain apatite and to partially or nearly completely enclosed in pyroxene. Olivine is a minor but ubiquitous mineral. On the basis of X–ray diffraction patterns Chamois (1977 p.25) identified the olivine as fayalite.

Biotite is present as anhedral, tabular to ragged brown crystals in close association with pyroxene and amphibole. While some biotite may be primary most would appear to have formed directly or indirectly by the breakdown of pyroxene. Some biotite also formed by the breakdown of primary amphibole. Biotite was noted as an alteration product of olivine, and it also occurs as rims on magnetite grains. Biotite may form from the direct breakdown of pyroxene without the development of an intermediate amphibole stage; in other cases the biotite may form from amphibole that resulted from pyroxene breakdown.

Apatite is a ubiquitous accessory mineral. It occurs as anhedral to euhedral rod–like crystals in association with the mafic components. It is poikilitically enclosed in pyroxene and olivine and since biotite and amphibole are breakdown products of these minerals it is also poikilitically enclosed in these two minerals.

The clinopyroxene is colourless, anhedral and may occur as isolated grains or as polycrystalline clusters of several grains. A schiller structure present in some of

the larger grains is due to very small oriented opaque inclusions. The inclusions occur in two sets but not at right angles. Chamois (1977 p.25) measured an angle of 70° between the two sets. The pyroxene interlocks with the feldspars and poikilitically encloses olivine, magnetite and apatite. Chamois (1977 p.25) reported iddingsite and chlorophaeite alteration of the pyroxene but it was not observed by the author.

The pyroxene is commonly rimmed with amphibole. The amphibole also nearly always encloses a grain of anhedral magnetite. The amphibole and magnetite are breakdown products of the pyroxene. Rarely biotite may have formed directly from the pyroxene but it appears to have resulted mainly from the subsequent breakdown of the amphibole. The pyroxene appears to be augite in composition, based on optical determination. Chamois (1977 p.25) has also indentified the pyroxene as augite.

Magnetite is commonly associated with amphibole and biotite and appears to have formed largely by the breakdown of the primary minerals pyroxene and olivine. Minor isolated magnetite grains and magnetite that is poikilitically enclosed within the pyroxene are likely primary in origin. The magnetite is anhedral in outline.

Plagioclase (An 26–34) occurs in three forms: anhedral grains forming an interlocking mosaic of grains; antiperthite; and isolated grains enclosed within perthite. The plagioclase grains interlocked with perthite and the cuspate grain margins on some plagioclase inclusions imply replacement of the plagioclase by the perthitic potassium feldspar. Morphology of some inclusions within perthite is suggestive of replacement by potassium feldspar along cleavage directions. Bending of albite twin planes in some grains implies that the plagioclase originally had a protoclastic texture which has been masked by the perthite replacement. Replacement of plagioclase along a line of flexure in one grain may suggest that points of stress on a bent crystal have a greater potential for replacement than unstressed areas.

Plagioclase has been noted to rarely poikilitically enclose pyroxene, biotite and amphibole. The irregular and in some cases amoeboid–like perthite grains partially engulf plagioclase grains while plagioclase may occur as distinct relicts or inclusions within perthite. It is not uncommon to observe perthite with patches or vestiges of albite twinning merging ghost–like into clear perthite. This twinning is likely inherited from former plagioclase which is in an advanced state of reconstitution into a more uniform perthite. On the whole, the plagioclase grains tend to be smaller than the perthite grains, and plagioclase–plagioclase grain boundaries are curved to lobate. Since the plagioclase grains are smaller than the perthite, they often appear interstitial to the somewhat larger perthite grains.

The amphibole is pleochroic brown, green–brown to green and almost universally rims pyroxene. It uncommonly occurs as distinct grains without relict pyroxene cores and in these cases may be primary in origin. Magnetite which also results from pyroxene breakdown is almost always associated with amphibole. Magnetite may be absent from some of the isolated possible primary grains. The pleochroism suggests an iron–rich amphibole.

Perthite is the most abundant mineral within the green syenite (unit 6a). Perthite occurs both as stringy and patchy types. The string perthite occurs as anhedral, sometimes amoeboid grains with pronounced lobate to serrate perthite–perthite grain boundaries. The potassium feldspar can often be seen to have clearly replaced plagioclase. Replacement is evidenced by cuspate or embayed grain boundaries on angular to subangular plagioclase inclusions within perthite

and by patchy ghost–like vestiges of albite twinning within the perthite grains. A narrow untwinned albitic(?) rim may be rarely present on some perthite grains.

The patch perthite is an antiperthite resulting from patchy replacement of plagioclase feldspar by potassium feldspar. On the larger grains minor offsets of albite twin planes can visually be extrapolated across perthitic areas and bending of the albite twin planes is evident. The morphology and distribution of the unreplaced plagioclase imply that replacement took place selectively along fractures, cleavages and possible areas of flexure in the plagioclase grains.

Perthite enclosing euhedral to anhedral pyroxene was noted. Carlsbad twinning may be present on some of the larger grains. One large perthite grain displays a ring of anhedral amphibole inclusions near the perimeter of the grain.

Perthite commonly occurs as grains somewhat larger than the average plagioclase grains but it also occurs as grains of roughly equivalent size interlocked with plagioclase grains.

Perthite grains in several instances consist of a fine–grained perthite with large wormy exsolutions. These have a symplectic appearance and are gradational into distinct grains. The string plagioclase is oriented normal to the long axis of the perthite grains and so are the coarser wormy exsolutions. Symplectite may visually compose up to 15% of a thin section but it is generally much less. Symplectite occurs in elongate grains separating the other feldspars or as irregular amoeboid–like grains. The wormy exsolutions are oriented normal to the margins of the elongate grains and the amoeboid grains. The wormy exsolutions may have a crudely radial pattern in the amoeboid–like grains. While the symplectite may in some cases, represent quartz–feldspar intergrowths, the author is of the opinion that they are more likely feldspar–feldspar intergrowths. The intergrowths are too fine–grained for definitive optical study.

The feldspars of the syenite are generally fresh but occasional traces of saussuritization may be present.

Brown Pyroxene Syenite

The brown olivine–bearing, biotite–pyroxene syenite (unit 6b) is essentially identical to the green syenite (unit 6a). In the field this unit was subdivided from the green variety on the basis of colour, i.e., brown versus green, and the visual presence of hornblende. Both rock types weather to similar colours. In thin section the brown syenite is texturally and mineralogically similar to the green syenite the major difference being the dominance of amphibole over pyroxene in the brown syenite. Amphibole without pyroxene was identified in several thin sections. The amphibole is undoubtedly primary in some of these rocks. This rock unit tends to occur towards the margins of the complex. The textural and mineralogical details of both rock types are essentially identical.

Granite

On the north flank of the complex are several outcrops of granite (unit 6c). The rock has a mineral composition similar to the other rocks of the complex but in addition has an abundance of quartz. The rock is brown to pink–brown on weathered surface and pink–green on fresh surface. In thin section the rock is fine to medium grained, massive, equigranular, hypidiomorphic. The mode is estimated to be 4 to 5% biotite, 1 to 10% clinopyroxene, 0 to 5% amphibole, 1 to 2% magnetite, 0 to 10% plagioclase (An 10?) 15 to 20% quartz and 69 to 72% perthite. The mineralogy and texture of biotite, clinopyroxene, amphibole and

magnetite appear identical to that described for the green syenite (unit 6a). The plagioclase is texturally similar to that described for the green syenite but more sodic in composition.

The perthite forms anhedral to euhedral grains and displays a well developed string texture. Crystal faces are sharp where they project into the quartz.

The quartz is interstitial to the perthitic feldspar and anhedral in outline. The quartz is late in the paragenetic sequence. The quartz lacks wavy extinction and some actinolite needles were noted to be closely associated with the quartz in one thin section.

Fine–Grained Syenite

Fine–grained syenite (unit 6e) is identical mineralogically with the green and brown syenites (units 6a, 6b). The rock is texturally fine–grained which may reflect chilling of the syenitic magma. The rock has weathered and fresh surface colours similar to the green and brown syenites.

In thin section the rock is fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. The rock has a tendency towards being more granoblastic with less lobate grain boundaries than the coarser–grained phases. The clinopyroxene content appears higher and the degree of alteration of the clinopyroxene to amphibole, magnetite, and biotite appears to be less extensive. This unit was not extensively examined in thin section.

Inhomogeneous Syenite

Syenites of this group (unit 6g) represent texturally inhomogeneous rocks which appear mineralogically variable on the outcrop scale. This unit is generally restricted to the area of the contact and to dike–like apophyses in the country rock. Xenolithic syenite also displays textural and mineralogical heterogeneity and would thus fall into this group. Because of the variable nature of this rock unit thin sections were not prepared from it. Xenolithic phases may be contaminated even though visual evidence for assimilation of the xenolithic material was not observed.

One thin section was prepared from a fine–grained syenitic rock occupying a fracture or joint in the syenite on the northern portion of the complex. This fracture filling is a very fine–grained, massive, equigranular amphibole syenite.

The amphibole composes 25% of the rock, and is anhedral in form. The amphibole is pleochroic in dark green–brown and may partially enclose feldspar grains.

The plagioclase (An 13–15?) forms approximately 20% of the rock and is anhedral in form. The plagioclase displays weak saussuritization.

Perthite with a string texture comprises an estimated 55% of the rock. The perthite forms an interlocking mosaic of grains interlocked with the plagioclase.

In thin section the rock is fine grained, equigranular, allotriomorphic, with lobate grain boundaries. The rock is an aplitic phase of the syenite and likely represents a late fracture filling emplaced within the cooling essentially solid syenite body.

Red–Brown Syenite

Red–brown syenite (unit 6k) is highly variable in its mineral components. The minerals and textural relations are generally similar to the green and brown

syenites except for the general tendency of this map unit to be somewhat richer in biotite. Alignment of the biotite may impart a schistosity to the outcrop.

The rock weathers pink–brown to red–brown and on fresh surface is red–brown. It occurs most abundantly within the centre of the complex.

In thin section the rock is fine to medium grained, equigranular to in-equigranular–seriate, allotriomorphic, with straight to lobate grain boundaries. Some sections have a nearly granoblastic texture. It is possible that these more biotitic rocks, and particularly those that display a schistose nature may be deformed or slightly sheared and recrystallized.

The mode is estimated to be 0 to 10% biotite, 2 to 10% clinopyroxene, 0 to 15% amphibole, 1 to 2% magnetite, 25 to 45% plagioclase (An 28–40) and 33 to 53% perthite. The reader should refer to the green syenite (unit 6a) for a description of the minerals and their interrelationships which are the same as for this rock unit.

A sample collected from the outcrop located approximately 1.6 km southwest of the Hopkins Township Syndicate drill hole no. 5 is different from the other samples of this rock unit as well as the other rocks of the complex.

In thin section the rock is fine to medium grained, inequigranular–seriate, allotriomorphic, microporphyroblastic, granoblastic, with curved to serrate grain boundaries. The texture is clearly metamorphic.

The mode is estimated as being 5% pyroxene, 10% amphibole, 25% plagioclase (An 40), 5% biotite, 2% magnetite and 48% perthite.

The clinopyroxene is anhedral, colourless, may poikilitically contain magnetite, and has altered to biotite, amphibole and magnetite.

The amphibole (other than that replacing pyroxene) forms anhedral to subhedral grains, is pleochroic in brown to red–brown, and poikilitically encloses rounded blebs of plagioclase and perthite. The texture is a typical metamorphic sieve texture.

The plagioclase (An 40) forms ragged, anhedral crystals and variations in birefringence across some grains indicate some compositional zonation in the larger grains. The plagioclase has a tendency to occur in clusters and is more calcic than the plagioclase found within the other rocks of the complex.

The biotite (other than that replacing pyroxene) is poikiloblastic and ragged in outline. The biotite poikilitically encloses magnetite, olivine, plagioclase and perthite. The biotite, like the amphibole, displays a well developed sieve texture.

Minor anhedral magnetite is present and is poikilitically enclosed in pyroxene, biotite and amphibole.

The perthite is a string perthite, anhedral in form. The perthite may form slightly larger grains than the plagioclase.

Sphene and olivine are present in trace amounts.

The rock, on the basis of this one section, is classified as a biotite–pyroxene–amphibole syenodiorite. Satterly examined diamond drill hole No.5 and classified rocks from that location as biotite gabbro (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The southwestern portion of the Clay–Howells Alkalic Rock Complex may represent a more mafic or more alkali–deficient phase than the central or northeastern portion. The lack of outcrop and definitive aeromagnetic pattern (ODM–

GSC 1964a,b) prevents any attempt at lithologic subdivision in this area. The suggestion of a more mafic composition combined with the presence of metamorphic textures also suggests that this portion of the complex may be older than those phases found towards the centre and northeast.

SYENITE CONTACT ROCKS

This map unit (unit 6j) does not outcrop but the diamond drill logs of Mattagami Lake Mining Company Limited and Chibougamau Mining and Smelting Company Incorporated indicate its presence.

The following descriptive data is the result of thin section examination of a suite of core samples made available to the Ontario Geological Survey through the courtesy of the Pickands Mather Company. Examination of the syenites from the Mattagami Mining magnetite deposit indicates a general similarity between syenites bordering the mineralization and those syenites more distant from the mineralization. Petrographic examination of the syenites, however, indicates that the pyroxene next to the mineralization is green aegirine–augite rather than colourless augite that typically occurs more distant from the zone. It is uncertain whether the sodic pyroxenes are the result of crystallization or the result of a metasomatic halo around the carbonatite intrusion. Although the aegirine–augite syenite may represent a distinct intrusive phase of the Clay–Howells complex, it likely formed by metasomatism coincident with carbonatite emplacement. The rocks containing sodic pyroxene display granoblastic textures and increasing pyroxene content towards the carbonatite.

It is uncertain whether the mafic syenite of the Mattagami Mining deposit is the same rock unit as that logged by Chibougamau Mining to the north of the deposit.

Aegirine–Augite Syenite

The aegirine–augite syenite is pink in colour and medium to coarse grained. The aegirine–augite syenite in drill core appears, in thin section, to be texturally identical to the augite syenite located some distance from the carbonatite intrusion.

In thin section the rock is fine to coarse grained, equigranular to inequigranular–seriate, allotriomorphic with curved to straight grain boundaries. An estimate of the mode is 0 to 35% amphibole, 45 to 79% perthite, 0 to 30% aegirine–augite, 0 to 25% biotite and 0 to 25% plagioclase (An 2–21).

The amphibole occurs as anhedral, green, green–brown to brown–green grains interlocked with the feldspar and often it has clearly replaced and mantled pyroxene. Some of the amphibole has replaced the pyroxene in a patchy fashion. Some of the individual amphibole grains are ragged in outline, equant and interlock with biotite. In one thin section containing carbonate, the amphibole poikilitically encloses rounded blebs of carbonate. Sphene and apatite were rarely noted to be poikilitically enclosed within the amphibole. The deep green pleochroic colour of the amphibole suggests that it is a sodium–iron variety.

Perthite is present as two distinct types. The dominant type is a string perthite which could also be described as braided. The perthite forms anhedral, irregular, interlocking grains, and locally displays Carlsbad twinning. Some perthite grains have clear, colourless rims of albite. The perthite–perthite grain boundaries are generally lobate to serrate.

Minor patch replacement antiperthite occurs as anhedral, locally tabular grains of plagioclase with extensive patchy replacement by potassium feldspar.

Discrete plagioclase grains occur between the perthite grains. The plagioclase grains are of albite–oligoclase composition and in places display offset of albite twin planes, implying the development of a weak protoclastic texture. The plagioclase grains tend to be smaller than the perthite grains.

The clinopyroxene is a green to dark green aegirine–augite commonly altered to amphibole. The pyroxene grains are commonly relict within a thick mantle of amphibole and are somewhat smaller relative to the individual amphibole grains. The pyroxene is anhedral and equant in form. Magnetite and apatite have been observed to be poikilitically enclosed within the pyroxene. Magnetite, amphibole and biotite occur as breakdown products of the pyroxene.

Biotite is present in a number of thin sections as tabular brown to red–brown pleochroic grains. The biotite commonly encloses or mantles magnetite. In one thin section small inclusions with dark haloes are interpreted to be radioactive zircons with radioactive–bombardment haloes. Biotite has commonly formed by the alteration of amphibole and pyroxene.

Magnetite in quantities of up to 5% is a common accessory mineral within the aegirine–augite syenite. The magnetite is disseminated, anhedral in form, and appears to have formed dominantly from the breakdown of the other mafic minerals. Magnetite is preferentially associated with biotite and amphibole, both of which are dominantly alteration products of pyroxene.

Minor to trace mineral components are olivine altered to iddingsite, carbonate, apatite, sphene, zircon, fluorite, epidote, quartz and cancrinite(?).

Closer to the carbonatite the texture of the syenite changes. The perthitic texture of the feldspar disappears and the feldspars become finer grained, nonperthitic, and granoblastic. The rocks are finer–grained than the normal syenites and are commonly darker coloured due to an increase in amphibole and pyroxene content. The first evidence of this change was observed in one thin section where elliptical perthite grains are enveloped in fine–grained granoblastic nonperthitic feldspar. Disseminated magnetite is common between the granoblastic feldspar grains and along the margins of the perthite grains. The colour darkening, increase in magnetite and mafic mineral content and development of a granoblastic texture are interpreted by the author to be the result of iron metasomatism and not a different intrusive phase.

Marginal to the carbonatite a strictly granoblastic texture develops. The texture of the aegirine–augite syenite becomes fine grained, massive, equigranular, allotriomorphic, granoblastic, with straight to curved grain boundaries. The textural change is due to the development of a contact metamorphic hornfels in conjunction with metasomatism marginal to the carbonatite intrusion. The clear, nonperthitic, homogenized feldspar has the optical values of orthoclase. The pleochroism of the amphibole and pyroxene indicates they are sodium–iron–rich varieties suggesting that sodium metasomatism accompanied iron metasomatism.

Fine–Grained Syenite with Mafic Veins

Close to the carbonatite, narrow zones of fine–grained syenite are veined with dark mafic veins that impart a brecciated appearance to the drill core. The fine–grained syenite is granoblastic and typical of the recrystallized hornfelsed syenite marginal to the carbonatite. On the basis of two thin sections the mafic fracture fillings are composed predominantly of amphibole. In thin section the granoblastic aegirine–augite syenite is gradational into a fracture filling consisting of a somewhat coarser grained, dark brown–green, pleochroic amphibole. Brown to

red–brown biotite is commonly associated with the amphibole. Minor carbonate may be present along the centre of the fracture. One thin section contains fluorite along a fracture. A thin section of a reaction rim on a syenite xenolith in carbonatite contains wollastonite and garnet in anhedral grains. Within this thin section the reaction rim on the syenite xenolith is composed of successive zones of carbonate, magnetite, garnet and wollastonite from the margin inwards. The associated aegirine–augite is turbid or clouded and the feldspar markedly decreases in quantity marginal to the carbonatite host.

The alteration mineralogy is indicative of sodium–rich metasomatism.

Alkalic Granite

Examination of the drill core indicates possible dike–like, fine–grained, pink to red–brown, quartz–rich aplitic phases. These fine–grained rocks are located in proximity to the carbonatite although they were not observed to cut the carbonatite. All the samples of this lithology are from hole 29 and rarely exceed 2 m of core length. Contacts with other phases are sharp.

In thin section the rock is fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. It is uncertain from the texture whether these rocks have been metamorphosed or are aplites. The mode is estimated to be 10 to 20% quartz, 5 to 20% amphibole, 55 to 65% perthite and 10 to 15% plagioclase (An 2–16). Trace amounts of apatite and magnetite are present.

The plagioclase forms anhedral grains interlocked with other plagioclase grains and perthite. The perthite is a microperthite with a string texture. It forms anhedral grains interlocked with other perthite and plagioclase grains. The quartz forms anhedral, clear grains interstitial to the feldspars. The amphibole forms anhedral, irregularly shaped, dark brown–green pleochroic grains. The amphibole may poikilitically contain minor magnetite. Trace amounts of aegirine–augite pyroxene and apatite are present.

A thin section was also prepared from a fine–grained dark green–black rock which contains visible quartz. Texturally the rock is similar to that described above. The rock contains an estimated 20% quartz, 30% perthite and 50% aegirine–augite. These dikes (?) likely represent pre–carbonatite granite aplite intrusions; the latter dike has been somewhat altered.

Mafic Syenite

Fine–grained mafic rocks separate the syenite rocks from the carbonatite and in all probability result from the interaction of the carbonatite magma with its syenite host. On the basis of a similarity in appearance with malignitic and ijolitic rocks found within other alkalic rock – carbonatite complexes the author originally mapped these rocks as ijolite and malignite. Thin section examination, however, failed to disclose the presence of significant nepheline which is critical for the application of these rock names. The rocks are therefore mafic syenites containing biotite, amphibole and pyroxene in varying proportions and have granoblastic textures. These rocks are gradational into more "normal" syenite and into carbonate–rich silicocarbonatite. The rocks are black, green–black, to dark green in colour. Relatively homogeneous sections are not common.

In thin section the rocks are fine to medium grained, massive, equigranular, allotriomorphic, granoblastic, with curved grain boundaries.

The mode is variable and is estimated to be 10 to 30% aegirine–augite, 5 to 60% feldspar (anorthoclase), 20 to 50% amphibole, 1 to 35% biotite and 0 to

15% magnetite. Carbonate is common in amounts varying from trace to 15% and a number of thin sections contain myrmekite in amounts approaching 15%. Trace to minor amounts of zircon, fluorite, apatite, nepheline and zeolite(?) are present.

The aegirine–augite occurs as dark green, anhedral, equant grains. The pyroxene is commonly rimmed with amphibole in which it occurs as relict cores. The feldspar forms anhedral, clear grains that, optically, closely approach anorthoclase. The feldspar grains form a granoblastic mosaic of interlocked grains. The feldspar grains locally form anhedral, sometimes amoeboid, optically continuous grains enclosing one or more of the mafic components: pyroxene and/or amphibole. In one thin section the larger feldspar grains poikilitically contain crude rings of non–oriented amphibole. This poikilitic relationship is somewhat similar to inclusion rings observed by the author along the ijolite–nepheline syenite contact in the Lackner Lake Alkalic Rock Complex.

The amphibole occurs as anhedral irregular grains which may enclose pyroxene relicts, magnetite and biotite. The amphibole is a dark green–brown to brown–green, strongly pleochroic and undoubtedly a high iron–sodium variety. Carbonate occurs poikilitically enclosed in amphibole in several thin sections. The amphibole and pyroxene content of one thin section exceeds 70% and the rock could be classified as a carbonated metapyroxenite.

The biotite occurs as anhedral, tabular, brown to red–brown grains. The biotite forms interlocking grains with the pyroxene and amphibole and is at least in part an alteration product of these two minerals. Biotite poikilitically encloses carbonate, magnetite, amphibole and pyroxene.

The magnetite is disseminated, anhedral, and often occurs poikilitically as grains within biotite and amphibole.

Carbonate, when present, occurs as anhedral, interstitial grains. As the amount of carbonate increases the amount of biotite and magnetite increases and the amount of pyroxene and amphibole decreases.

Very fine–grained, symplectic intergrowths of feldspar and an as yet unidentified mineral occur in a number of thin sections. These fine–grained intergrowths may constitute up to 15% of some thin sections. The intergrown mineral with feldspar is at times birefringent and at other times rather neutral. Tentatively the author suggests that these symplectites are nepheline–feldspar intergrowths and that the birefringent component is altered nepheline and that the neutral one is fresh nepheline. These intergrowths are similar to those resulting from the breakdown of pseudoleucite as described by Watkinson (1973) but they have also been interpreted as the product of late–stage magmatic crystallization (Gittins *et al.* 1980). These intergrowths require additional study and if the presence of nepheline is confirmed then some of these rocks will likely approach a true malignite in composition. Until the presence of nepheline is confirmed the author classifies these mafic rocks as hornfelsed mafic syenites with their respective mineralogic modifiers. In addition, these mafic syenites have formed by a process involving some addition of iron and sodium and thus are the result of fenitization of the syenite host rocks by the intruding carbonatite.

CARBONATITE

Nowhere within the complex is carbonatite (unit 6h) known or reported to outcrop. Description of this rock is based solely on diamond drill core samples provided by the Pickands Mather Company. All magnetite–rich sections had been

split for assay and were not available to the author in sufficient size to thin section. Thin sectioned samples were from homogeneous, biotite–rich, unsplit sections of the core.

The carbonatite appears to be a dike–like intrusion into the syenites of the Clay–Howells complex. Diamond drilling by Pickands Mather Company indicates that the magnetite–bearing carbonatite approaches to within 5 m of the surface.

In thin section the rock is fine–grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries.

The mode is highly variable and is estimated to be 0 to 50% biotite, 5 to 40% magnetite, 20 to 55% carbonate, 10 to 20% aegirine–augite and approximately 5% apatite.

The biotite forms tabular, anhedral to subhedral, red–brown, pleochroic grains. A number of grains display bent (001) cleavages.

The magnetite forms disseminated, anhedral to subhedral grains throughout the core.

The carbonate forms an interlocking mosaic of anhedral grains. Chamois (1977) identified the presence of dolomite, however, it composes less than 5% of the carbonate mineralogy.

The clinopyroxene is an anhedral, equant, rounded mineral. The pyroxene is pale green in colour and poikilitically contains carbonate, apatite and magnetite. Pyroxene poikilitically enclosed in magnetite is also present. The pyroxene within one thin section is turbid and has undergone alteration to an optically unidentifiable mineral(s).

The apatite is disseminated throughout the thin sections as round to round–elongate, anhedral to subhedral grains.

The carbonate samples examined in thin section are classified as silicocarbonatites. Trace to minor amounts of albite, olivine, fluorite and pyrochlore are present.

The pyrochlore occurs as discrete grains within and along the edges of magnetite grains. The mineral is dark brown, subhedral to euhedral in outline, and isotropic to weakly birefringent.

Shklanka (1968) reported that within the main area of mineralization the carbonatite varies from 10 to 80% magnetite. Chamois (1977) prepared polished sections of this magnetite and identified the presence of ilmenite lamellae within the magnetite. These ilmenite lamellae occur along the (111) crystallographic planes of the magnetite. Trace amounts of pyrite, chalcopyrite, pyrrhotite and marcasite are present (Chamois 1977). The sulphides occur in close association with the magnetite (Chamois 1977).

Spectrographic examination of small chips of the magnetite mineralization indicated anomalous quantities of niobium, zinc, molybdenum and tin, however, the niobium in the mineral pyrochlore is the only anomalous element occurring in a recognizable mineral phase.

DIKE ROCKS

Dike rocks (unit 7) cutting the Clay–Howells complex are relatively rare; most outcrops are massive and relatively homogeneous. Dike rocks were observed cross–cutting coarse–grained syenite along or close to the Mattagami and Kapuskasing Rivers along the east flank of the intrusion and at one helicopter stop within the centre of the complex.

Amphibole Syenite Dikes

Amphibole syenite dikes (unit 7c) outcrop in two places along the east flank of the complex with the best exposure being along the Kapuskasing River. The exposure along the shoreline is a fine- to medium-grained pink-grey syenite in sharp contact with the coarse-grained syenite. The rock is pink-grey on fresh surface and has a very well developed trachytoidal texture along its contact with the coarser syenite due to the preferred orientation of platey feldspar. This well developed trachytoidal zone is approximately 3 cm wide and is gradational into the much less trachytoidal core of the dike. The dike appears to be relatively flat-lying, is on the order of approximately 1.5 m thick, and may have been a late-stage residuum emplaced along a fracture in the cooled syenite. Several very fine-grained autoliths (chilled contact facies of the dike) occur along the margins of the dike and xenoliths of coarse-grained syenite up to 3 by 1 cm are also present. Narrow tongue-like apophyses of the syenite project into the coarse syenite (Photo 2).

In the field the diagnostic feature of the amphibole syenite dikes is the presence of easily recognizable acicular amphibole.

In thin section the rock is fine grained, massive, equigranular, hypidiomorphic. The mode is estimated to be 25% amphibole, 20% albite and 55% perthite. Biotite is present in minor amounts. The amphibole is acicular, pleochroic, dark green-brown, subhedral, and twinned. The amphibole may be an iron-rich variety. Albite to oligoclase plagioclase is anhedral to almost euhedral in form and occurs interlocked with perthite. Both string and patch perthite occur. The patch perthite is antiperthite and likely represents potassium feldspar replacement of the plagioclase; the string perthite likely resulted from exsolution. The rock was classified as amphibole syenite.

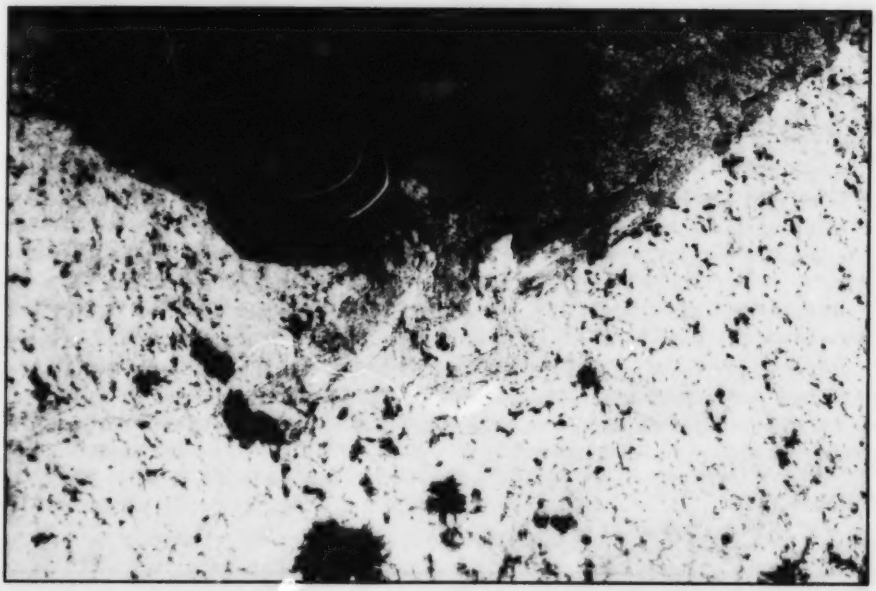

Photo 2. ***Amphibole syenite dike with well developed trachytoidal texture cutting coarse-grained pyroxene-amphibole syenite.***

A second, similar, dike was noted on the northeast corner of the complex, in from the shore of the Mattagami River. This dike is 18 cm wide and has a trend of 105°. In thin section the rock is very fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. The mode is estimated to be 10% amphibole, 20% biotite, 40% albite–oligoclase and 30% perthite. The amphibole appears identical to that described for the first dike. The biotite occurs as tabular, brown, anhedral to subhedral grains. The mica has a generally random orientation. The feldspars are interlocking, anhedral and display curved to straight grain boundaries. The rock was classified as amphibole–biotite syenite.

Melanocratic Syenite

At an outcrop within the core of the complex a small mafic dike (unit 7d) cuts coarse grained syenite. The dike is grey on weathered and fresh surfaces. It is fine grained, lacks the acicular amphibole of the amphibole syenite dikes, has an irregular trend, and is approximately 20 cm wide. Contact with the coarse–grained syenite is sharp, however, several aplitic stringers of similar dike rock with diffuse contacts were present in the same area cutting the coarse–grained syenite. The dike contains xenoliths of coarse–grained syenite up to 5 to 6 cm wide.

In thin section the dike rock is fine to medium grained, massive, inequigranular–porphyritic–seriate, allotriomorphic, with straight to curved grain boundaries. The mode is estimated to be 30% clinopyroxene, 10% magnetite, 10% amphibole, 28–30% plagioclase, 5% perthite and a trace of quartz.

The clinopyroxene forms anhedral, rounded, colourless grains scattered throughout. The amphibole is pleochroic in green to green–brown and occurs as an alteration of pyroxene or as distinct grains. The magnetite is anhedral and disseminated throughout the thin section. The plagioclase forms anhedral, interlocking grains. One large poikiloblastic–appearing plagioclase grain poikilitically contains inclusions of randomly oriented pyroxene and magnetite. The minor perthite forms anhedral grains interlocked with the plagioclase. The rock is melanocratic amphibole–pyroxene–oligoclase syenite.

PETROLOGY

During mapping, sampling was conducted in routine fashion and samples selected for their freshness and homogeneous appearance. A group of these samples was chosen for whole–rock chemical analysis (Appendix A). The chemical analyses cannot be used to define silicate melt trends since it is likely that the body was emplaced as a crystal mush. Replacement features are common in the feldspars suggesting some alkali addition subsequent to feldspar crystallization. The accompanying AFM diagrams (Figure 4) are for comparative purposes only.

In Figure 4a, granite (unit 6c) plots on or close to the alkali–Fe join. The sample population is too limited to be considered representative. The location of the two samples on the AFM plot implies the rock is highly evolved and likely residual.

Analyses of green olivine–bearing pyroxene syenite (unit 6a) are clustered near the alkali–Fe join (Figure 4b), indicating a low MgO content and an evolved magma.

Analyses of brown olivine–bearing pyroxene syenite (unit 6b) are clustered in the same region as the green syenite (Figure 4c). Field relations and petrography suggest that the two rock units are gradational into each other and therefore a similarity in the AFM plot is to be expected. Three samples of pyroxenite ob-

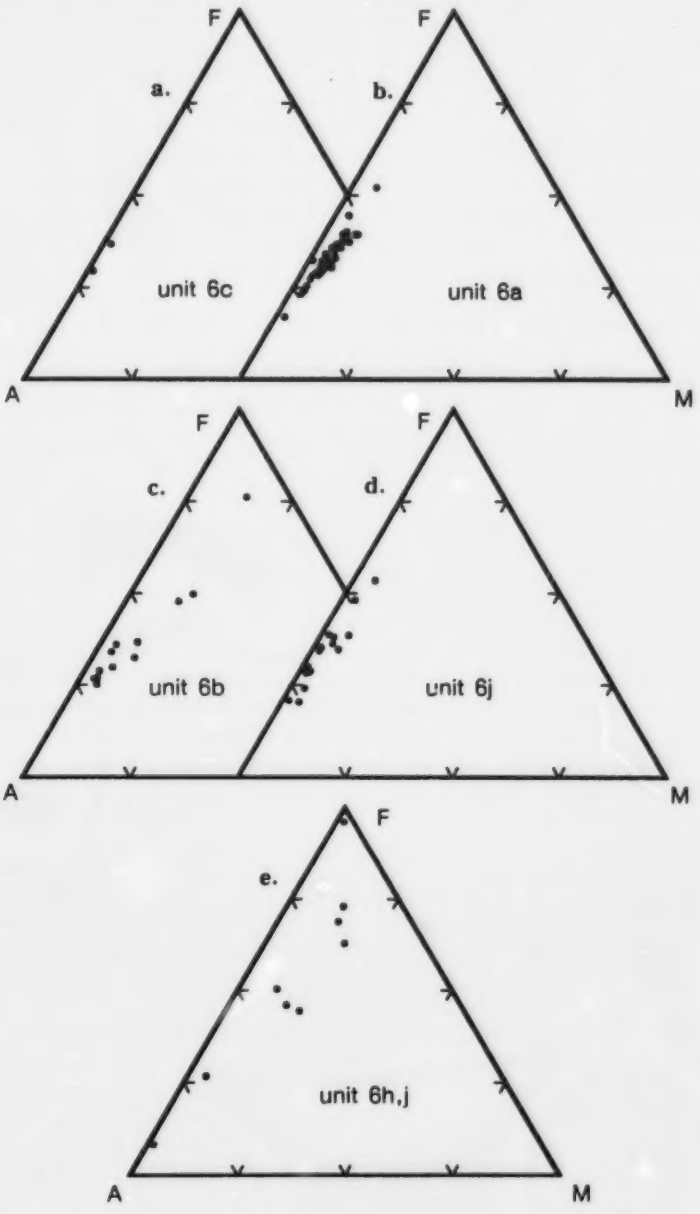

Figure 4. *AFM plots of samples from the Clay-Howells Alkalic Rock Complex.* **a.** *Granite, unit 6c.* **b.** *Green, olivine-bearing syenite, unit 6a.* **c.** *Brown, olivine-bearing syenite, unit 6b.* **d.** *Syenitic rock from diamond drilling, unit 6j.* **e.** *Syenite dikes, mafic syenite, sovite and silicocarbonatite from diamond drilling, units 6h,j.* $A = Na_2O + K_2O$; $F = FeO$ *(total);* $M = MgO$.

tained from Mattagami Mining Company drill core are also plotted on Figure 4c. The point scatter suggests high degree of variability in composition.

Syenitic rocks from drill core of Mattagami Mining Company Limited have a distribution (Figure 4d) similar to the green syenite (unit 6a). The area of the diagram covered is somewhat greater than that covered by the green syenite implying some samples are enriched in iron and others in alkalies relative to the green syenite. As previously discussed, this rock unit has likely undergone iron–alkali metasomatism.

The AFM plot in Figure 4e shows alkalic granite dike rocks (unit 6j) found in diamond drilling, three mafic syenites, and five samples of sovite and silicocarbonatite (unit 6h). The dikes may represent a melt equivalent but their relationship to the complex is unknown. The mafic syenites plot towards the centre of the diagram and are likely products of iron metasomatism and do not represent melt equivalents. The carbonatite rocks plot near the Fe apex of the diagram and are likely an immiscible fraction from an unknown parent. The metasomatic halo around the carbonatite suggests that alkali and iron were lost from the original carbonatite magma to the enclosing rocks and that the present carbonatite rock must therefore be considered a residuum.

Normative compositions and statistical compositions of the lithologic units are given in Appendix A.

GEOCHRONOLOGY

Gittins *et al.* (1967) published the first isotopic age data for the Clay–Howells Alkalic Rock Complex. Using K–Ar techniques they obtained an isotopic age of 1010 Ma.

Bell and Blenkinsop (1980), using samples collected during the present survey, obtained a Rb–Sr isochron age of 1072 $\pm$ 16 Ma. They reported a $^{87}Sr/^{86}Sr$ ratio of 0.7027 $\pm$ 0.0005 indicating there was no significant crustal contamination of the Clay–Howells magma.

METAMORPHISM

Gneissic rocks bordering the complex are typical of those found within the Kapuskasing Subprovince of the Superior Province of the Canadian Shield. Bennett *et al.* (1967a, p.18–19) considered these gneisses to be the metamorphosed equivalent of felsic to mafic volcanic rocks, sedimentary rocks, and mafic to felsic intrusive rocks. These rocks have been metamorphosed to the granulite facies rank of regional metamorphism (Bennett *et al.* 1967, p.18).

Examination of a limited number of thin sections of the gneissic rocks has indicated variable quantities of hornblende, pyroxene, plagioclase, quartz, garnet and biotite. Bennett *et al.* (1967, p.18) reported the presence of hypersthene which was not confirmed in sections examined by the author. Bennett *et al.* (1967, p.18) reported that biotite is rare. Biotite is fairly abundant in some of the samples examined by the author. While clinopyroxene is fairly abundant in the suite of samples examined by the author, it has ubiquitously undergone replacement by amphibole. Biotite also occurs as a replacement of amphibole and pyroxene. Trace to very minor amounts of chlorite and fibrous amphibole are rarely present. The gneissic rocks appear to have undergone a retrograde metamorphism under hornblende hornfels facies conditions (Turner and Verhoogen 1960, p.553–557).

Diabase dikes of several types cut the gneissic rocks along the Mattagami and Kapuskasing Rivers. These dikes are undeformed in outcrop and display sharp contacts with the gneissic rocks. In thin section the plagioclase of these dikes is relatively fresh. The pyroxene, however, is pervasively altered to hornblende and occasionally biotite, chlorite and fibrous amphibole are also present. The breakdown of the pyroxene within the diabase and gneissic rocks appears to be similar. Since the diabases cut the gneissic rock and display chill margins to the gneisses, they are definitely younger than the gneisses. It must then be considered that the retrograde metamorphism of the gneisses and the metamorphic event that affected the crosscutting dikes may be the same event. If the metamorphism of the granulites and dikes are considered the same, it suggests a metamorphic overprint of lower hornblende hornfels facies (Turner and Verhoogen 1960, p.508–516) on the gneissic rocks in conjunction with metamorphism of the diabase dikes. The diabase dikes were not observed to cut the unmetamorphosed syenite rocks of the complex; this metamorphic event would thus be later than diabase emplacement and earlier than or contemporary with syenite emplacement. Tentatively the author would suggest that gneissic rocks of the granulite facies rank of regional metamorphism have been overprinted by the hornblende hornfels facies of contact metamorphism, likely associated with emplacement of the Clay–Howells Alkalic Rock Complex. The retrograde textures found within the gneisses marginal to the complex should be compared with samples some distance from the complex to support or modify this tentative conclusion.

The syenites of the complex are essentially unmetamorphosed. Patch perthite (antiperthite) is common in syenite samples from throughout the complex. Irregular, anhedral to subhedral grains of plagioclase have undergone patchy replacement by potassium feldspar giving rise to clear areas of potassium feldspar separated by ghost–like areas of twinned albite plagioclase. The two feldspars have diffuse contacts with each other. This texture is considered by the author to be due to autometamorphic or deuteric phenomenon associated with the terminal phase of cooling of the syenite. The breakdown of the olivine and pyroxene to amphibole, biotite and magnetite are also considered by the author to be part of this autometamorphic or deuteric process.

In the amphibole–pyroxene–biotite syenite, local shearing and recrystallization are indicated by a schistose appearance in outcrop, a somewhat higher than normal biotite content, and the local suggestion of a granoblastic texture.

The pronounced poikiloblastic texture found in the sample collected 1.6 km southwest of the Hopkins Township Syndicate diamond drill hole No. 5 is not typical of the textures observed within samples collected from this complex. The biotite and amphibole found within rocks from this outcrop have a well developed sieve texture due to poikilitically enclosed rounded blebs of plagioclase and perthite. The significance of this texture is not clear because it was observed in only one sample and there is a lack of outcrop and definitive aeromagnetic pattern in that area. On the basis of chemistry this rock represents a less differentiated magma than the other samples examined from the complex. Perhaps this rock was emplaced earlier in the sequence of events and has been subjected to thermal metamorphism by a later more differentiated magma represented by the bulk of samples examined. In the field the rock does not clearly display evidence of metamorphism and the outcrop appears relatively homogeneous.

Textural changes within the syenite bordering the carbonatite intrusion in the southeast corner of the complex have clearly established that the carbonatite is later. Syenite samples from drill core proximal to the carbonatite contain

aegirine–augite which contrasts sharply with the calcic pyroxene that occurs ubiquitously throughout the other areas of the complex. The textures of these samples are otherwise similar to that found throughout the complex. This implies that the aegirine–augite syenite was a distinctly separate magma that crystallized with rock textures similar to the other syenites, or that the aegirine–augite was formed by replacement of an original calcic pyroxene by fluids associated with the carbonatite emplacement. The author prefers the latter interpretation.

Examination of core samples close to the carbonatite body indicates that they contain increasing quantities of sodic pyroxene and amphibole which locally occur in such quantity that the rocks could be classified as pyroxenites or hornblendites. This increase in mafic minerals rich in sodium and iron suggests extensive sodium–iron metasomatism. The fluid was likely aqueous and sodium–iron–bearing as suggested by Siemiatkowska and Martin (1975, p.1119) and the process was similar, if not identical, to fenitization.

The perthitic feldspar of the typical syenites becomes homogenized, finer–grained and granoblastic as the carbonatite is approached. The alkalic mineralogy of the syenitic rock inhibits rigorous classification as to metamorphic grade. The temperature of carbonatite magmas is likely relatively low compared to most other types of rock magmas. Heinrich (1966, p.270) suggested temperatures as low as 550°C. Consanguineous with the thermal event, the presence of pervasive metasomatizing fluids undoubtedly had some effect on the development of the metamorphic aureole. Considering the likely temperatures of emplacement of the carbonatite magma, the metamorphic aureole is probably equivalent in metamorphic rank to the hornblende hornfels to pyroxene hornfels facies of contact metamorphism (Turner and Verhoogen 1960, p.508–526). The carbonatite intrusion is thus enveloped in an aureole resulting from the interplay of thermal and metasomatic phenomena.

STRUCTURAL GEOLOGY

REGIONAL STRUCTURE

The Clay–Howells Alkalic Rock Complex lies within the Kapuskasing Subprovince of the Superior Province. This subprovince is characterized geophysically by a northeast–trending zone of gravity highs and pronounced linear aeromagnetic trends (Innes 1960, ODM–GSC 1970). This anomalous gravity zone has been interpreted to be due to an upwarp in the Conrad discontinuity caused by major regional faulting and the formation of a complex horst structure (Wilson and Brisbin 1965; Bennett *et al.* 1967). This prominent regional structure extends from the south end of Hudson Bay southwestward, where it becomes broader and more ill–defined as it approaches the Lake Superior basin. The Clay–Howells Alkalic Rock Complex has been emplaced into this structure, which also contains many other carbonatite alkalic complexes to the north and south.

Percival and Card (1983) interpreted the Kapuskasing Structural Zone as an upthrust oblique section through the Archean crust. To the east, high–grade rocks are in fault contact with low–grade rocks along a northeast–striking, northwest–dipping thrust fault. West of the thrust fault, the high–grade rocks grade into low–grade rocks over a distance of more than 100 km. The interpretation that the Kapuskasing Structural Zone is a tilted section through the Archean crust fits the observed field relations. The thrust faulting within the Kapuskasing Subprovince appears to have controlled the location of numerous carbonatite – alkalic rock

complexes which are located in a linear fashion along the Kapuskasing Subprovince (Structural Zone).

Bennett *et al.* (1967b) interpreted the complex to lie between or along major northeast–trending fault zones associated with the Kapuskasing Subprovince.

LOCAL STRUCTURE

The lack of outcrop and structural features within the syenite prevent any meaningful interpretation of emplacement mechanism for the complex. In the northwest corner of the body the gneisses strike roughly east and impinge at nearly right angles to the syenite. The gneisses appear to be little deformed by the emplacement of the syenite. This lack of deformation along the wall rock–syenite contact is a feature similar to that observed between the schists and syenites at the Killala Lake Alkalic Rock Complex (Sage 1988a).

Mapping within and near the margins of the syenite indicates that, in general, the xenolithic blocks of gneiss retain attitudes similar to those observed in the gneisses that enclose the complex. The lack of rotation of the xenolithic blocks implies passive emplacement. Considering the present surface area of the complex and lack of significant disruption of structural trends within the enclosing gneisses, the complex is likely mushroom–shaped in vertical cross–section. The feeders to this generally flat lying syenite sheet are likely one or more dike–like intrusions whose location and trend were controlled by regional faults that characterize the Kapuskasing subprovince. The carbonatite is a later dike–like body which has been emplaced into the syenite. Control of emplacement of this intrusion was likely effected by movement along a pre–existing northeast–trending fault zone lying beneath the syenite body.

The septum of gneissic rocks striking north–south along the Mattagami and Kapuskasing Rivers could perhaps be a preserved remnant of cover rocks resulting from ring fracturing and caldera subsidences at the time of emplacement.

An interpreted fault zone may cut the complex in a northwest direction and continue north from the intrusion along the north–trending Mattagami River. The possibility of such a fault is suggested by three observations: (1) inflection of structural trends in outcrops south of Devils Rapids which lie in close proximity to the northwest trending stretch of the Mattagami River; (2) the location of outcrops of gneissic rocks along the west side of the Mattagami River south of where gneisses could be implied by aeromagnetic data; and (3) examination of aeromagnetic contours (ODM–GSC 1964a, b) in Hopkins and Clay Townships. Aeromagnetic contours in Hopkins Township and the southwest corner of Clay Township indicate that two closures of isomagnetic contours could possibly be joined if a right lateral northwest–trending fault cuts the complex between the two areas.

MAGNETIC DATA

The Clay–Howells complex is covered by aeromagnetic maps 2305G and 2286G (ODM–GSC 1964a, b) (see Figure 2). The aeromagnetic maps, taken as presented, display closure of the isomagnetic contours which divides the complex into four crude subcomplexes. Removal of the postulated fault would decrease the number of closures to three. These subcomplexes may represent separate pulses of syenitic magma whose aeromagnetic pattern reflects minor variation in accessory magnetite content. Mapping, however, has disclosed relatively little variation in composition throughout the complex. The closure of isomagnetic contours and mapped outcrop indicate that the Clay–Howells complex is elliptical

and elongated in a northeast direction. The intrusion is approximately 15 km long and 9 km wide.

Within the enveloping gneissic terrain aeromagnetic data has been used to interpret the presence of faults and dikes (Bennett *et al.* 1967b).

RECOMMENDATIONS FOR FUTURE STUDY

A number of items remain for additional work. Additional petrographic study of the gneissic rocks at some distance from the complex is required so that metamorphic features can be compared in gneisses distal and proximal to the complex. The results of such a study may modify the interpretation presented here in the metamorphic section of this report. The significance of the metamorphic texture in the sample collected in the southwest extremity of the complex needs additional study.

Microprobe analysis of the mineral phases within the syenite is advisable and extensive microprobe study of the carbonatite mineralogy is desirable. The thermal–metasomatic aureole to the carbonatite warrants further study.

The author, at this time, considers the carbonatite as being fortuitously emplaced within the syenite and that a cogenetic relationship need not exist. An attempt to date the carbonatite should be made to see if an isotopic age difference can be established between the syenite and carbonatite.

Spectrographic analysis of the mineralized carbonatite indicates anomalous concentrations of zinc, tin and molybdenum. It is desirable that studies be undertaken to determine how these elements are carried within the carbonatite and whether they have potential economic interest.

Mapping has failed to disclose silica–undersaturated syenitic rocks or rocks of the ijolitic suite. The syenites examined appear to be more closely analogous to those of the Port Coldwell Alkalic Rock Complex or perhaps the more central portions of the Killala Lake Alkalic Rock Complex; neither of these complexes contains carbonatite (Puskas 1967; Coates 1970). The paragneissic and amphibolitic rocks enclosing the Clay–Howells Alkalic Rock Complex lack evidence of fenitization which is characteristic of carbonatite intrusions.

The development of metasomatic rocks characteristic of carbonatite intrusions is restricted to the margins of the carbonatite dike–like body containing the Mattagami Mining magnetite deposit. Present observations suggest that the syenitic rocks found within the complex and the magnetite–bearing carbonatite drilled by Mattagami Mining Company Limited in the southeast corner of the complex are possibly two distinctly different and perhaps unrelated alkalic intrusions. The lack of rock types considered characteristic of those alkalic intrusions containing mineralization of economic interest decreases significantly the chances of finding niobium, uranium, apatite, etc. associated with this complex.

Niobium and anomalous tin, zinc and molybdenum are known to exist within the magnetite–bearing carbonatite (Table 2). The economic significance of these four elements awaits additional work.

PROPERTY DESCRIPTIONS

The following descriptions were abstracted from assessment work files (Assessment Files Research Office, Ontario Geological Survey, Toronto).

ARGOR EXPLORATIONS LIMITED [1966]

Argor Explorations Limited completed one diamond drill hole totalling 153 m (501 feet) on an airborne–detected geophysical anomaly northwest of the syenite–gneiss contact. This drill hole encountered disseminated to nearly massive sulphides (pyrite and pyrrhotite) in association with paragneiss.

BEWABIK MINERALS LIMITED [1958]

Bewabik Minerals Limited completed two diamond drill holes totalling 827.2 m (2,714.0 feet) on claim S–78793. This drilling disclosed minor concentrations of magnetite. The claim is presently part of the holdings of the Mattagami Mining Company Limited.

CHIBOUGAMAU MINING AND SMELTING COMPANY INC. [1957]

The Chibougamau Mining and Smelting Company Inc. completed a ground magnetometer survey and three diamond drill holes totalling 579.7 m (1,902 feet) on a claim group known as the Spencer option on the east flank of the complex. Some minor concentrations of magnetite were encountered.

In the same year, the company also completed a ground magnetometer survey and five diamond drill holes totalling 936.7 m (3,073 feet) on a second group of claims known as the Bradley option on the southeast flank of the complex. This drilling disclosed mostly syenitic rocks with minor carbonate and hornblende concentrations.

TABLE 2. TRACE ELEMENT ANALYSIS OF MAGNETITE-RICH SAMPLES, CLAY-HOWELLS CARBONATITE COMPLEX.

Sample	CH29 529.0	CH29 660.0	CH29 711.0	CH29 751.3	CH29 762.0
Ag(s)	<1	<1	<1	1	<1
Be(s)	25	8	25	<1	<1
Ga(s)	5	10	4	2	7
Mo(a)	5	20	10	50	85
Nb(s)	450	900	1500	1000	2000
Sc(s)	15	10	6	45	5
Sn(s)	10	10	9	930	60
Sr(s)	>3500	>3500	>3500	>3500	1000
V(s)	15	15	30	20	40
Y(s)	300	350	600	1000	700
Zr(s)	300	300	250	200	350
Ce(x)	2000	4500	3200	2800	6500
La(s)	1000	1500	2500	1000	1500
Nd(s)	600	700	>0.1%	>0.1%	>0.1%
Cu(a)	12	22	8	6	19
Zn(a)	620	760	760	4500	2820
Ni(a)	70	62	<5	<5	<5
Co(a)	14	13	5	9	15
Pb(a)	52	80	93	265	72
Cr(a)	23	170	11	7	5
TiO_2(a)	0.40%	0.50%	0.10%	0.10%	0.30%

Sample	CH29 823.5	CH29 906.5	CH29 947.7	CH29 1005.4	CH29 1022.0
Ag(s)	<1	<1	<1	<1	<1
Be(s)	<1	5	<1	15	6
Ga(s)	<1	10	2	40	4
Mo(a)	75	25	10	10	5
Nb(s)	300	1500	1500	2000	1500
Sc(s)	6	15	10	15	20
Sn(s)	9	9	9	40	10
Sr(s)	>3500	>3500	>3500	1500	>3500
V(s)	25	20	20	15	20
Y(s)	25	450	200	60	250
Zr(s)	150	250	300	600	250
Ce(x)	500	2900	1000	500	1600
La(s)	150	2000	70	150	1000
Nd(s)	<300	800	700	<300	450
Cu(a)	8	9	5	5	6
Zn(a)	2620	1250	550	2280	1480
Ni(a)	<5	26	<5	<5	<5
Co(a)	10	14	<5	8	8
Pb(a)	80	180	68	30	173
Cr(a)	<5	64	<5	16	5
TiO_2(a)	<0.10%	0.70%	0.20%	0.80%	<0.10%

Samples provided by Pickands Mather Co., Cleveland, Ohio.
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
Data in ppm unless otherwise stated.
(a) – Atomic absorption
(s) – Spectrographic
(x) – X-ray fluorescence

TABLE 2. CONTINUED.

Sample	CH29 1031.5	CH29 1043.0	CH30 208.5	CH30 215.2	CH30 234.2
Ag(s)	<1	<1	<1	<1	<1
Be(s)	40	7	<1	4	6
Ga(s)	70	60	3	3	3
Mo(a)	35	5	20	10	10
Nb(s)	>0.2%	>0.2%	1400	500	1000
Sc(s)	30	30	10	10	9
Sn(s)	120	150	6	7	6
Sr(s)	1000	400	>3500	>3500	>3500
V(s)	20	20	25	35	10
Y(s)	450	100	900	700	500
Zr(s)	600	>0.1%	250	150	150
Ce(x)	2000	500	2100	3800	2300
La(s)	600	90	1500	2000	1500
Nd(s)	<300	<300	>0.1%	>0.1%	>0.1%
Cu(a)	1	8	5	8	<5
Zn(a)	3900	2800	590	2880	490
Ni(a)	<5	<5	<5	<5	<5
Co(a)	10	11	5	9	<5
Pb(a)	85	48	111	129	100
Cr(a)	<5	5	12	5	<5
TiO_2(a)	<0.10%	0.60%	0.20%	0.10%	0.10%

Sample	CH30 284.9	CH30 319.5	CH30 370.0	CH30 392.5	CH30 507.3
Ag(s)	1	<1	<1	<1	<1
Be(s)	3	<1	15	15	7
Ga(s)	1	5	3	8	7
Mo(a)	<5	10	5	5	10
Nb(s)	600	2000	600	250	>0.2%
Sc(s)	10	10	10	15	20
Sn(s)	7	20	15	15	150
Sr(s)	>3500	>3500	>3500	1500	>3500
V(s)	10	20	60	20	80
Y(s)	350	600	250	150	600
Zr(s)	200	150	250	350	>0.1%
Ce(x)	4700	2300	2600	1900	4000
La(s)	2000	1000	1000	550	3000
Nd(s)	>0.1%	600	450	250	450
Cu(a)	21	6	160	7	7
Zn(a)	2660	1950	1060	650	4100
Ni(a)	<5	<5	66	16	<5
Co(a)	14	8	24	8	9
Pb(a)	80	52	81	35	420
Cr(a)	<5	19	64	760	13
TiO_2(a)	0.10%	<0.10%	1.0%	0.70%	0.30%

TABLE 2. CONTINUED.

Sample	CH102 263.3	CH102 461.1	CH102 462.6	CH102 491.7	CH104 425.0
Ag(s)	<1	<1	<1	<1	<1
Be(s)	5	5	4	<1	<1
Ga(s)	10	8	15	7	5
Mo(a)	10	30	30	20	35
Nb(s)	1500	900	650	200	350
Sc(s)	<5	<5	<5	<5	<5
Sn(s)	5	15	15	6	7
Sr(s)	>3500	1000	300	>3500	>3500
V(s)	15	15	20	25	15
Y(s)	450	60	35	150	80
Zr(s)	250	150	150	150	150
Ce(x)	5100	1500	1100	4800	1200
La(s)	2500	500	200	2500	450
Nd(s)	>0.1%	<300	<300	800	300
Cu(a)	-	6	7	8	6
Zn(a)	-	1010	1070	860	350
Ni(a)	-	<5	<5	<5	<5
Co(a)	-	6	8	8	7
Pb(a)	-	18	16	17	44
Cr(a)	-	16	23	19	10
TiO_2(a)	-	0.20%	0.20%	0.10%	0.20%

HOPKINS TOWNSHIP SYNDICATE [1956]

In 1956, the Hopkins Township Syndicate completed six diamond drill holes totalling 1124 m (3,747.0 feet) on an aeromagnetic anomaly in the centre of Hopkins Township (see ODM–GSC 1964a). The rocks encountered were described as monzonite to gabbro containing disseminated magnetite.

MATTAGAMI MINING COMPANY LIMITED

The Mattagami Mining Company Limited is a subsidiary of Pickands Mather Company, the Steel Company of Canada, and Interlake Iron Corporation (Ferguson 1971). The claim group of the company covers an aeromagnetic anomaly discovered by Lundberg Explorations Limited in 1954. A grubstake syndicate of Lundberg employees completed an initial 2,000 feet of diamond drilling on the anomaly.

In 1958 the Mattagami Mining Company Limited completed a ground magnetometer survey over the mineralized zone and 4539.0 m (14,891.7 feet) of diamond drilling (Assessment Files Research Office, Ontario Geological Survey; private records, Pickand Mather Company, Cleveland, Ohio). The drilling outlined a magnetite deposit and the company subsequently patented the claims covering the deposit.

Drilling has indicated a northeast–striking carbonatite body 1050 m long, 90 m wide, composed of 10 to 80% magnetite (Shklanka 1968). This body dips 60° northwest and is estimated to contain 10 million tonnes of mineralization (Shklanka 1968). Shklanka (1968) reported that magnetic concentrates from a small sample assayed 70% iron, less than 2% SiO_2 and 0.06% sulphur.

Ferguson (1971) reported that the magnetite is non–titaniferous, but Chamois (1977) reported the presence of some ilmenite lamellae within the magnetite. Niobium was present in the concentrate and tailings of a sample used for a mill

recovery test (Ferguson 1971) and its presence in the mineral pyrochlore has been confirmed both by the author and by Chamois (1977).

Spectrographic analysis (Geoscience Laboratories, Ontario Geological Survey) of very small chips of the mineralization provided to the Ministry by Pickands Mather Company indicates anomalous concentrations of tin, zinc and molybdenum. Minerals which contain these elements as a major component were not recognized by the author or Chamois (1977) and the economic significance of these elements awaits additional work.

Ferguson (1971, p.33) reported that diamond drill hole No. 6 showed 6 to 7 times background radioactivity from 277.6 to 278.3 feet, but that most of the magnetite–rich sections were only slightly radioactive.

RECOMMENDATIONS TO THE PROSPECTOR

Mapping has failed to disclose silica–undersaturated rocks such as nepheline syenite and ijolite which are commonly associated with carbonatite uranium–niobium mineralization. The iron and niobium mineralization found on the property of Mattagami Mining Company Limited is associated with a dike–like body of carbonatite emplaced into the syenite complex and the syenite and carbonatite are not necessarily related intrusions.

The syenite does not contain sufficient accessory apatite or magnetite to be considered of economic importance. By–product apatite may have economic importance if the carbonatite is exploited for its iron content or iron–niobium content. Apatite is estimated to form approximately 5% of most of the carbonatite samples examined in thin section. Pyrochlore, a source of niobium, is likely to be a by–product of any attempt to extract iron from the carbonatite.

The feldspars of the syenite commonly display a golden sheen in bright sunlight which might make this rock an attractive building stone.

The prospector would be best advised to prospect for other carbonatite intrusions within the syenite complex or its enveloping wall rocks. Carbonatite intrusions that remain to be found are likely to be dike–like bodies striking in a northeast direction. Since most of the region has been extensively covered by aeromagnetic surveys, any undiscovered carbonatites probably contain little magnetite.

Appendix A — Petrographic Descriptions, Chemical Analyses, Normative Compositions, and Statistical Compositions of Lithologic Units of the Clay–Howells Alkalic Rock Complex.

TABLE A-1. PETROGRAPHIC AND FIELD DESCRIPTIONS OF WHOLE-ROCK SAMPLES* FROM THE CLAY-HOWELLS ALKALIC ROCK COMPLEX.

Reference No. 954
Sample No. C6-1

Biotite granite.

Field Description. Medium grained, massive, equigranular. Visual quartz is present. Weathered surfaces are brown, fresh surfaces green. Map-unit 6c.

Petrographic Description. Medium to coarse grained, massive, equigranular, hypidiomorphic. Quartz is anhedral and interstitial. Minor clinopyroxene is undergoing alteration and turbid in nature. Pyroxene is anhedral. Magnetite is anhedral and disseminated. Biotite forms isolated grains and felty aggregates with minor chlorite. Perthite forms anhedral to euhedral interlocking crystals; euhedral crystal faces project into quartz. Traces of epidote(?) and carbonate are present.

Reference No. 955
Sample No. C6-3

Biotite, pyroxene granite.

Field Description. Medium to coarse grained, massive, porphyritic. Feldspar phenocrysts in seriate distribution form up to 20% of the rock. Visual quartz is abundant. Weathered surfaces are pink-brown, fresh surfaces pink-green. Map-unit 6c.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Quartz forms anhedral, interstitial grains. Minor fluorite and actinolite are present. Turbid clinopyroxene is undergoing alteration to magnetite, amphibole and biotite. Biotite forms anhedral grains in association with amphibole. Magnetite is disseminated in association with biotite and amphibole. Amphibole forms irregular grains, in most cases after pyroxene. Plagioclase (An 10) forms anhedral grains interlocking with perthite and plagioclase. Perthite displays a stringy texture, and forms anhedral to euhedral crystals; the crystals project into quartz.

Reference No. 956
Sample No. C6-5

Olivine-bearing, quartz, amphibole, pyroxene, biotite syenite.

Field Description. Medium to coarse grained, massive, equigranular, locally tending towards porphyritic. Outcrop displays weak alteration along some joints which may weather in relief. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, hypidiomorphic. Olivine is anhedral, altered to iddingsite. Biotite forms small clusters of anhedral grains, and is largely an alteration of pyroxene. Amphibole is acicular, possibly actinolite, formed as an alteration of pyroxene. It also occurs as needle-like crystals in quartz. Quartz is anhedral, interstitial. Clinopyroxene occurs as isolated relicts in its alteration products, i.e. amphibole, biotite, magnetite. Perthite is coarse, stringy and anhedral. Some Carlsbad twinning is present. Some perthite grains have a narrow albite rim and a texture approaching antiperthite.

Reference No. 957
Sample No. C80-14

Olivine-bearing, biotite, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive; occurring within porphyritic seriate syenite. Weathered surfaces are yellowish brown, fresh surfaces brownish green. Some areas of outcrop appear

**Reference numbers for outcrop samples are plotted on Figure 3 (Chart A). The locations of drill core samples are indicated on Figure 3 by the drillhole numbers. Sample numbers prefixed with C are outcrop samples. Sample numbers prefixed with CH are drill core samples (all drill core samples are from Mattagami Mining Co. Ltd. drill holes); e.g. sample CH104-317.0 is from Mattagami Mining hole no. 104 at a depth of 317.0 feet.*

more leucocratic than others. Locally on outcrop surfaces there are minor pegmatitic segregations which contain traces of quartz. Feldspar phenocrysts are up to 4 mm in maximum dimension. Pegmatitic phases lie within a somewhat finer grained phase of outcrop. Map-unit 6a.

Petrographic Description. Medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to lobate grain boundaries. Pyroxene forms colourless, anhedral to subhedral grains. Some grains have oriented magnetite inclusions imparting a schiller texture to the mineral. Amphibole forms dark greenish-brown rims on pyroxenes and often encloses magnetite. Amphibole and magnetite result from breakdown of the pyroxene. Magnetite occurs as anhedral grains, generally rimmed with amphibole and magnetite and marginal to the pyroxene. Biotite appears to result from breakdown of pyroxene and/or amphibole. Olivine forms anhedral, rounded crystals with dark brown alteration along curved cracks. Smaller grains may be completely altered to reddish-brown iddingsite. Apatite forms anhedral to subhedral crystals which may occur poikilitically in olivine, pyroxene, amphibole or magnetite. Perthite forms anhedral grains with a stringy texture. Locally non-perthitic areas of feldspar grains have vestiges of albite twinning. Plagioclase (An 32?) occurs as small anhedral grains interstitial to the perthite feldspar. Traces of interstitial quartz are present.

Reference No. 958
Sample No. C8-16

Biotite, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Fresh surfaces are brown to yellowish-brown, weathered surfaces brown. Map-unit 6b.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Plagioclase (An 28-30) forms anhedral grains between perthite grains and occurs as irregular to angular patches within perthite. Plagioclase is being replaced by perthite. Bending of albite twin planes on some plagioclase grains imparts a local protoclastic texture to the rock. Perthite has a well developed stringy texture and forms anhedral grains with curved to lobate grain boundaries. Pyroxene is anhedral to subhedral, colourless and may have oriented inclusions giving it a schiller texture. Amphibole is pleochroic in brown to greenish-brown; it rims pyroxene and commonly completely encloses magnetite. The amphibole and magnetite appear to have resulted from the breakdown of pyroxene. Traces of biotite and minor apatite are present.

Reference No. 959
Sample No. C18-1B

Amphibole syenite.

Field Description. Fine to medium grained, inequigranular, porphyritic, seriate. Feldspar phenocrysts up to 6 mm comprise 10 to 15% of rock. The mafic mineral forms acicular needle-like crystals. Platey feldspars give the rock a very well developed trachytoidal texture. The rock is a dike cutting coarse syenite, and contains xenoliths of coarse-grained syenite and autoliths of fine-grained dike material. Apophyses of the dike penetrate into coarse-grained syenite. Weathered surfaces are pink, fresh surfaces pinkish-red. The dike is irregular in shape but appears to have a roughly horizontal attitude. Map-unit 7c.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Biotite forms anhedral, brown grains interlocking with amphibole. Amphibole is a dark green-brown pleochroic, acicular mineral; some grains are twinned. Amphibole is anhedral to subhedral in form. Albite forms anhedral to almost euhedral crystals. Perthite occurs both as patch perthite and stringy perthite. Some grains contained sufficient plagioclase to be classified as antiperthite. Grain boundaries are curved to lobate.

Reference No. 960
Sample No. C19-2

Biotite-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces yellowish-brown to brown. Minor, coarse-grained, pegmatitic segregations comprise less than 1% of the outcrop. Map-unit 6b.

Petrographic Description. Medium to coarse grained, massive, inequigranular, seriate, allotriomorphic, with curved to lobate grain boundaries. Plagioclase (An 26-30) forms anhedral grains between perthite grains or forms the dominant phase in antiperthite. Perthite is of two types: string perthite occurs as anhedral, irregular grains; patch perthite is an anti-perthite representing potassium replacement of the plagioclase. The areas of replacement have the texture of a string perthite. Pyroxene is an anhedral to subhedral clinopyroxene commonly rimmed with amphibole. Amphibole is pleochroic in brown to dark greenish-brown; it rims pyroxene and

encloses or is associated with magnetite. Magnetite is anhedral and closely associated with amphibole. Magnetite and amphibole are replacing the pyroxene. Minor biotite is interlocked with pyroxene and amphibole and appears to result from pyroxene or amphibole breakdown. A trace of apatite is present.

Reference No. 961
Sample No. C19-3

Amphibole, pyroxene syenite.

Field Description. Coarse grained, massive. Weathered surfaces are brown, fresh surfaces brown to yellowish-brown. Locally, very minor coarse-grained pegmatitic segregations occur within the syenite. Map-unit 6b.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic with lobate to serrate grain boundaries. Perthite forms an interlocking mosaic of grains. Perthite of both patchy and stringy type occurs. Patch perthite has vestiges of albite twinning. An occasional small plagioclase grain is enclosed in perthite. Distinct grains of plagioclase (An 36) form a minor component. Plagioclase grains interlock with perthite. Clinopyroxene forms anhedral to subhedral grains. Pyroxene occurs in aggregates and poikilitically encloses apatite. The pyroxene is green to dark green in colour; rarely grains have a schiller-like texture from needle-like inclusions oriented in two sets at 60°. Magnetite forms anhedral grains generally within or closely associated with amphibole. Amphibole occurs as the result of pyroxene breakdown and mantles pyroxene or occurs as isolated replacements along grain margins. The amphibole is a dark brown to greenish-brown in colour. Apatite occurs as subhedral to euhedral crystals poikilitic in pyroxene and its breakdown products.

Reference No. 962
Sample No. C20-3

Amphibole syenite.

Field Description. Fine to medium grained, inequigranular, porphyritic-seriate. Feldspar phenocrysts up to 7 mm across comprise 15 to 20% of rock. Fresh surfaces are reddish to pinkish red, weathered surfaces brown. Map-unit 6a.

Petrographic Description. Fine to medium grained, equigranular, allotriomorphic, with curved to lobate grain boundaries. Amphibole forms anhedral, interstitial, dark green brown, pleochroic grains. Biotite forms brown anhedral grains in association with amphibole. Plagioclase forms rounded, irregular grains commonly enclosed in perthite. Grains are likely of albite-oligoclase composition. Perthite forms irregular, anhedral grains and some perthite is patchy. Traces of interstitial quartz are present.

Reference No. 963
Sample No. C20-8

Amphibole syenite.

Field Description. Fine grained, massive, equigranular. Mafic minerals are somewhat elongate. It is unclear whether the rock is a dike cutting coarse-grained syenite or a xenolithic block within the syenite. Weathered surfaces are pinkish brown, fresh surfaces pink. Map-unit 6b.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Minor anhedral plagioclase (An 10-12) is interstitial to perthite. Larger grains are being replaced by potassium feldspar. Amphibole forms anhedral, irregular, dark greenish brown, pleochroic grains. Traces of magnetite are poikilitic in amphibole. Perthite forms anhedral to subhedral grains with well developed stringy texture and local patches of albite twinning. Perthite-perthite grain boundaries tend to be lobate and a thin rim of clear albite encompasses most grains.

Reference No. 964
Sample No. C20-8B

Biotite, magnetite, olivine amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Locally the texture coarsens towards pegmatite. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Olivine forms anhedral, rounded grains in part altered to iddingsite. Biotite forms anhedral, brown grains in association with magnetite and amphibole. Amphibole is dark greenish brown and may have relict pyroxene; it is closely associated wih magnetite and biotite. Magnetite occurs as isolated, disseminated grains within amphibole and associated with minor biotite. Apatite occurs as euhedral grains poikilitic in pyroxene and amphibole. Clinopyroxene is present as relict cores in amphibole and as grains with amphibole

mantles. Plagioclase (An 10) forms minor anhedral grains interlocking with other plagioclase and perthite. Perthite is anhedral, forming interlocking grains with stringy texture. Perthite grains have narrow clear albite rims.

Reference No. 965
Sample No. C20-12A

Olivine, biotite, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. The outcrop has minor, small pegmatitic phases which grade into the coarse-grained rock. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with straight to lobate grain boundaries. Biotite forms brown, anhedral grains rimming pyroxene. Pyroxene forms anhedral, colourless grains of clinopyroxene in part altering to biotite. Magnetite forms anhedral, disseminated grains poikilitic in pyroxene and in association with biotite. Perthite forms anhedral, irregular grains with stringy perthitic texture; patchy albite twinning is present. Olivine forms anhedral grains in association with pyroxene and its alteration products, i.e. biotite and magnetite. Olivine is fresh and altered to iddingsite. Minor euhedral apatite occurs in association with pyroxene.

Reference No. 966
Sample No. C20-17

Olivine and biotite-bearing, amphibole, magnetite, pyroxene syenite.

Field Description. Coarse grained, equigranular, massive. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An 10?) forms anhedral grains interlocking with plagioclase and perthite. Perthite is stringy and forms an interlocking mosaic of anhedral grains. It may enclose angular to subangular plagioclase grains. Patchy potassium feldspar replaces plagioclase. Apatite is euhedral and poikilitic in pyroxene. Pyroxene is a clinopyroxene, colourless, and often mantled with dark greenish brown amphibole. Amphibole is dark greenish brown, mantling pyroxene. Magnetite is anhedral and occurs in close association with amphibole and biotite. Olivine forms anhedral grains in part altering to reddish brown iddingsite.

Reference No. 967
Sample No. C20-25

Olivine, magnetite, pyroxene, amphibole syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Olivine forms anhedral grains in part altered to iddingsite. Apatite forms anhedral grains poikilitic in pyroxene. Amphibole forms anhedral, irregular dark greenish brown grains. Some grains have relict pyroxene cores and some grains also enclose magnetite. Pyroxene is a colourless clinopyroxene occurring as relicts in amphibole. Magnetite forms anhedral, irregular grains often enclosed in amphibole. Plagioclase occurs as minor, anhedral grains interlocking with perthite. Perthite is an anhedral stringy perthite with rare patch perthite. Perthites form an interlocking mosaic of anhedral grains with lobate grain boundaries.

Reference No. 968
Sample No. C20-30

Leucocratic syenite.

Field Description. Coarse grained, massive, equigranular, more leucocratic than normal. Weathered and fresh surfaces are pinkish brown. Relationship to sample C20-30B (below) uncertain but appears to be gradational. Map-unit 6a.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorpic. Plagioclase (albite-oligioclase) forms anhedral to subhedral irregular grains sometimes poikilitic in perthite. Traces of magnetite are locally rimmed by biotite. Perthite forms anhedral, irregular grains with stringy and patchy perthite textures. Perthite grain boundaries are lobate.

Reference No. 969
Sample No. C20-30B

Olivine, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are reddish brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Stringy perthite grains form an interlocking mosaic. Grain boundaries are commonly lobate. Patchy perthite formed by potassium feldspar replacement of plagioclase. Pyroxene is a colourless clinopyroxene, anhedral in form, and in part rimmed by amphibole. Amphibole is dark greenish-brown and rims pyroxene. Apatite is euhedral and poikilitic in pyroxene. Plagioclase (albite-oligioclase) forms anhedral grains often undergoing patchy replacement by potassium feldspar. Olivine forms anhedral grains in part altering to iddingsite. Traces of a fibrous mineral occur in olivine. Minor magnetite and biotite occur as part of alteration of pyroxene.

Reference No. 970
Sample No. C21-2

Biotite, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with straight to lobate grain boundaries. Apatite is euhedral, elongate, poikilitic in pyroxene. Biotite occurs as minor, anhedral, interlocking grains marginal to magnetite grains. Magnetite occurs as rounded, irregular grains, always mantled with biotite or amphibole. Traces of olivine are altered to iddingsite. Plagioclase forms anhedral to subhedral grains, in part, enclosed in perthite. Pyroxene is a clinopyroxene, forming anhedral, irregular, clear to very pale green grains. Pyroxene is mantled with dark green amphibole, some biotite. Perthite forms anhedral grains and has stringy texture, with rare patchy perthite. Some perthite-perthite grain boundaries are lobate.

Reference No. 971
Sample No. C22-5

Olivine and biotite-bearing pyroxene, amphibole syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green to brownish green. Very faint streaking of mafic minerals occurs along the north side of the outcrop. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Pyroxene forms rounded, anhedral to subhedral crystals commonly thickly mantled with amphibole. It may be associated with altered olivine. Amphibole is pleochroic, brown to dark greenish-brown, and thickly mantles pyroxene. It may enclose anhedral grains of magnetite. Amphibole plus magnetite forms from pyroxene breakdown. Biotite and magnetite are minor and closely associated with pyroxene. Olivine is altered to iddingsite. Perthite forms anhedral grains, with stringy texture and rare Carlsbad twinning; there are local vestiges of albite twinning.

Reference No. 972
Sample No. C22-9

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, equigranular. Weathered surfaces are rusty brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Plagioclase (An 28) forms anhedral, irregular grains; larger grains are undergoing replacement by potassium feldspar. Larger grains have weak bending of albite twin planes indicative of weak protoclastic texture. Pyroxene is anhedral, clear, and thickly mantled with amphibole. Amphibole is pleochroic, brown to dark greenish-brown, commonly associated with and enclosing magnetite. Amphibole and magnetite have formed from breakdown of pyroxene. Olivine is minor and occurs as fresh grains with dark brown alteration along curved cracks. Some olivine is altered to iddingsite. Perthite forms anhedral grains with stringy texture. Perthite contains vestiges of plagioclase which are irregular in outline. Cuspate grain margins and morphology suggest replacement along cleavage planes.

Reference No. 973
Sample No. C23-2

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Outcrop is deeply weathered. Weathered surfaces are pinkish, fresh surfaces green to brownish green. Map-unit 6a

Petrographic Description. Fine to medium grained, inequigranular, seriate, allotriomorphic, with curved to lobate grain boundaries. Perthite forms an anhedral mosaic of interlocking grains

with lobate grain boundaries. Larger perthite grains are separated by smaller perthite grains. Anhedral clinopyroxene forms irregular grains mantled with amphibole and minor biotite. Minor biotite occurs in association with amphibole and magnetite. Amphibole forms anhedral, irregular grains mantling pyroxene. Amphibole may contain rounded, anhedral blebs of magnetite. Magnetite is anhedral; it commonly rims pyroxene. Olivine occurs as anhedral to subhedral crystals, commonly altered in part to iddingsite.

Reference No. 974
Sample No. C23-5

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Medium to coarse grained, massive, equigranular. Weathered surfaces are brown to pinkish brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, hypidiomorphic. Olivine forms rounded, irregular grains with limonitic (?) alteration along fractures and edges. Trace of a fibrous amphibole (?) occur in one grain. Pyroxene is a colourless anhedral clinopyroxene locally rimmed with dark greenish brown amphibole. Plagioclase (albite-oligoclase) forms anhedral to subhedral grains, commonly enclosed in perthite. Crystals are often rounded and may occur in poorly defined clusters. Perthite is of the stringy and patchy types and may completely enclose plagioclase. Apatite forms rounded, elongate, bead-like grains and may be poikilitically enclosed in olivine and pyroxene. Magnetite is commonly mantled with amphibole and likely is an alteration of pyroxene and/or olivine.

Reference No. 975
Sample No. C23-8

Olivine and biotite, bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces greenish brown. Mafic minerals weathering out give pitted surface to outcrop. In bright sunlight feldspars have a golden sheen. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Traces of apatite are poikilitic in olivine. Pyroxene is colourless, anhedral to subhedral in form, may have good schiller texture from oriented magnetite inclusions. Amphibole is pleochroic, brown to dark greenish-brown, and occurs in association with magnetite replacing pyroxene. Biotite forms brown, tabular grains, commonly after olivine, and also in association with amphibole and magnetite. Plagioclase (An 28-30) forms anhedral grains interlocking with each other and somewhat larger perthite grains. String perthite occurs as anhedral grains, commonly with irregular vestiges of albite twinning. Cuspate outline of plagioclase suggests replacement by the perthite.

Reference No. 976
Sample No. C23-10

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are rusty brown, fresh surfaces brownish-green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Apatite forms anhedral, rounded to elongate grains; it may occur poikilitic in olivine, pyroxene, amphibole. Olivine forms rounded grains, some altered to iddingsite; alteration of olivine occurs along curved fractures. Pyroxene is colourless, anhedral in form and undergoing replacement by amphibole. Amphibole is pleochroic, brown to dark greenish-brown, replaces pyroxene and is commonly associated with amphibole. Plagioclase forms anhedral grains generally small relative to perthite with which it is interstitial. Perthite forms anhedral, irregular grains with stringy texture; it may contain vestiges of albite twinning. Some patch antiperthite is present. Myrmekite is common along perthite grain boundaries. Wormy intergrowths are normal to grain boundaries.

Reference No. 977
Sample No. C23-12B

Olivine, biotite gabbro.

Field Description. Medium grained, equigranular, massive. Weathered surfaces are brownish-grey, fresh surfaces blackish-grey. The rock may be a very large block in coarse-grained syenite. Map-unit 6n.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic, subophitic. Plagioclase (An 48-54) forms clear, fresh, anhedral grains; weak bending of albite twin planes indicates a weak protoclastic texture. Biotite forms large ragged grains and poikilitically en-

closes pyroxene, plagioclase, and olivine. Biotite in part replaces pyroxene and commonly has minor, anhedral magnetite in association. Most biotite has bent (001) cleavage implying some deformation. Pyroxene is a clinopyroxene, colourless, anhedral and interstitial to plagioclase. Pyroxene may contain spotty alteration to biotite.

Reference No. 978
Sample No. C23-13

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Pyroxene is colourless anhedral to subhedral clinopyroxene. Amphibole is pleochroic brown to greenish-brown and rims pyroxene. It also occurs as angular, random inclusions in one large plagioclase grain. Amphibole is commonly associated with anhedral magnetite and both are from the breakdown of pyroxene. Plagioclase forms anhedral grains, generally small relative to perthite with which it is interstitial. Perthite forms anhedral, irregular grains with stringy texture. It may contain vestiges of albite twinning. Some patchy antiperthite is present. Myrmekite is common along perthite grain boundaries; wormy intergrowths are normal to grain boundaries.

Reference No. 979
Sample No. C23-17

Olivine and amphibole bearing, biotite, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, allotriomorphic, with lobate grain boundaries. The rock tends towards granoblastic. Olivine occurs as anhedral grains with dark brown alteration along curved cracks, and shows minor alteration to iddingsite. Olivine is closely associated with pyroxene. Pyroxene forms anhedral, colourless grains often replaced by amphibole and magnetite. Biotite forms brown, tabular crystals in part replacing pyroxene, amphibole, and olivine. Magnetite is closely associated with amphibole and biotite and is the result of pyroxene breakdown. Amphibole is a brown to greenish-brown in colour and replaces pyroxene, commonly enclosing magnetite. Perthite is a combination of stringy and patch types. Perthite grains have irregular vestiges of albite twinning scattered throughout. Grain boundaries are strongly lobate.

Reference No. 980
Sample No. C23-20

Olivine and amphibole-bearing pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are rusty brown, fresh surfaces brown to greenish-brown. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Minor olivine occurs in association with pyroxene, and is almost always altered to iddingsite. Pyroxene is anhedral, colourless and thickly mantled with amphibole and magnetite. Amphibole forms brown to green rims on pyroxene and is associated with and encloses magnetite. Magnetite is anhedral, closely associated with amphibole and with amphibole represents breakdown of the pyroxene. Myrmekite is abundant as complex wormy intergrowths, possibly quartz plus feldspar. Perthite is of two types, stringy and patchy. Patchy perthite is an antiperthite with spotty potassium replacement. Feldspar grain boundaries are strongly lobate.

Reference No. 981
Sample No. C23-26

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are rusty brown, fresh surfaces green to pale green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Apatite is anhedral to subhedral, poikilitic in olivine, pyroxene and amphibole. Olivine is anhedral, rounded to subangular, with dark brown alteration along curved cracks; it is locally altered to dark reddish-brown iddingsite. Biotite may be an alteration product of olivine and one grain has an amphibole rim of alteration. Biotite is present as isolated, tabular to ragged, brown grains, and as grains replacing amphibole after pyroxene, and rimming magnetite after pyroxene. Amphibole is a dark brown to greenish-brown and, with

anhedral magnetite, results from pyroxene breakdown. Stringy perthite forms anhedral grains with abundant vestiges of plagioclase. Cuspate potassium feldspar – plagioclase grain boundaries imply replacement of plagioclase by potassium feldspar. Albite twin planes can visually be extrapolated across areas of potassium replacement. Replacement feldspar may have stringy perthite texture. Sufficient plagioclase is present to classify some grains as antiperthite. Feldspar grain boundaries are lobate and interdigitate. Myrmekite is common and wormy intergrowths are normal to grain boundaries.

Reference No. 982
Sample No. C23-28

Olivine and biotite-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown to rusty brown, fresh surfaces brownish green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Minor olivine is altered in part to iddingsite. Minor anhedral biotite is associated with amphibole, magnetite and pyroxene. Pyroxene forms anhedral rounded grains which are colourless and often rimmed with amphibole. Amphibole is pleochroic in brown to dark greenish brown. Amphibole rims pyroxene and commonly encloses anhedral magnetite. Amphibole and magnetite appear to result from pyroxene breakdown. Perthite forms anhedral grains with stringy texture. Irregular vestiges of albite twinning are common. Plagioclase is anhedral and generally forms smaller grains interstitial to perthite.

Reference No. 983
Sample No. C23-29

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are rusty brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with lobate grain boundaries. Minor apatite is anhedral and poikilitic in olivine, pyroxene and amphibole. Olivine is anhedral, rounded to irregular, with dark brown alteration along curved cracks; it also shows some alteration to iddingsite. Olivine is closely associated with pyroxene. Pyroxene occurs as anhedral colourless grains in aggregates of several grains and is mantled with amphibole. Amphibole is dark brown to greenish brown and commonly associated with anhedral magnetite. Both minerals represent breakdown of pyroxene. Myrmekite is common, occurring between grains and wormy intergrowths perpendicular to grain margins. Perthite is anhedral and occurs as both stringy and patchy types. Stringy perthite contains local vestiges of unreplaced plagioclase. Patch perthite is commonly antiperthite and patchy replacements commonly have very fine grained stringy perthitic texture. Grain boundaries are lobate.

Reference No. 984
Sample No. C23-31

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green with some brownish mottling. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic with lobate to serrate grain boundaries. Olivine forms rounded to subangular grains with dark brown alteration along curved fractures and local alteration to iddingsite. Amphibole is pleochroic brown to reddish brown, commonly replacing pyroxene, but also occurring as irregular to ragged grains which are possibly primary. Where replacing pyroxene the amphibole is commonly associated with anhedral magnetite. Pyroxene is colourless, anhedral, and commonly rimmed with and replaced by amphibole and magnetite. Olivine is closely associated with pyroxene and may be partially enclosed by pyroxene. Perthite is stringy and vestiges of albite twinning may be present. Grain boundaries are lobate to serrate. Some Carlsbad twinning is present.

Reference No. 985
Sample No. C24-1B

Olivine, pyroxene, amphibole syenite.

Field Description. Coarse grained, massive, equigranular. There is a slight variation in mafic content over the outcrop area. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Clinopyroxene forms minor, anhedral grains in association with olivine. Pyroxene is undergoing alteration to amphibole. Olivine forms anhedral grains in part

altered to iddingsite and locally rimmed with biotite. Olivine is poikilitic in pyroxene. Apatite is euhedral and poikilitic in pyroxene. Magnetite forms anhedral, disseminated grains, poikilitic in pyroxene and also occurs as alterations of pyroxene and olivine. Amphibole is dark greenish-brown and anhedral; some amphibole is after pyroxene, some may be primary. Minor actinolite is present. Perthite forms anhedral, irregular grains with lobate grain boundaries and well developed stringy texture.

Reference No. 986
Sample No. C24-3

Magnetite, olivine, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. The outcrop contains small coarse-grained pegmatitic segregations and displays subtle weak mafic banding. A gabbroic mafic xenolith is present. Weathered surfaces are brown, fresh surfaces green to grey-green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Quartz is anhedral, interstitial. Anhedral grains of plagioclase (An 12) form an interlocking mosaic with perthite. Some offset of albite twin planes in several grains suggests former protoclastic texture. Larger grains are undergoing patchy potassium feldspar replacement giving rise to a patch perthite or antiperthite. Perthite is anhedral, forming a mosaic of interlocking grains with other perthite and plagioclase grains. Several grains of perthite contain angular to subangular grains of plagioclase. Magnetite forms anhedral grains in association with amphibole. Olivine forms anhedral, irregular grains largely altered to iddingsite. Apatite is euhedral and poikilitic in pyroxene. Clinopyroxene is anhedral and is mantled with amphibole. Amphibole is dark greenish-brown and almost exclusively an alteration of pyroxene.

Reference No. 987
Sample No. C24-4

Olivine-bearing amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces brown. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Olivine forms rounded grains altering to reddish-brown iddingsite; rare fresh grains have iddingsite rims. Pyroxene forms anhedral to subhedral grains with incipient alteration along rims to greenish-brown amphibole. Plagioclase (albite-oligoclase) forms anhedral to subhedral grains, often rounded and completely enclosed in perthite. Perthite forms irregular, anhedral grains and may enclose plagioclase grains. Perthite-perthite grain boundaries are somewhat lobate. Trace amounts of quartz, magnetite and myrmekite are present.

Reference No. 988
Sample No. C24-5

Magnetite, olivine, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces grey-green. Weak diffuse mafic banding is present on outcrop surface. Map-unit 6a.

Petrographic Description. Medium grained, equigranular, massive, allotriomorphic, with curved to lobate grain boundaries. Clinopyroxene is colourless, anhedral, and has amphibole rims. Some grains display a schiller texture. Plagioclase (An 8-14) forms an anhedral interlocking mosaic with some suggestion of a former protoclastic texture due to offset of albite twin planes. Olivine forms anhedral grains interlocking with pyroxene and in part altered to iddingsite. Amphibole is dark greenish-brown, pleochroic and forms rims on pyroxene. Disseminated magnetite and biotite occur in association with altering pyroxene. Perthite is an interlocking mosaic of anhedral grains. String perthite may contain angular to subangular inclusions of plagioclase. Patch perthite is a replacement of plagioclase which displays weakly developed protoclastic textures.

Reference No. 989
Sample No. C24-9

Magnetite, olivine, amphibole pyroxene syenite.

Field Description. Medium to coarse grained, equigranular, local pegmatitic segregations. Weathered surfaces are brown, fresh surfaces grey-green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with straight to lobate grain boundaries. Pyroxene is a clinopyroxene, anhedral to subhedral in form. Several grains have schiller texture. Amphibole rims pyroxene. Amphibole is greenish-brown and

pleochroic. Trace of biotite occur with amphibole alteration. Magnetite occurs as rounded, disseminated grains in association with amphibole alteration of pyroxene. Olivine forms anhedral grains in part altered to iddingsite. Perthite is stringy perthite with lobate interpenetrating grain boundaries. Minor, euhedral apatite is poikilitic in pyroxene.

Reference No. 990
Sample No. C24-17

Biotite, pyroxene, olivine syenite (tending towards leucocratic).

Field Description. Medium to coarse grained, equigranular, massive. A weak schistosity in the outcrop is due to orientation of mafic minerals. Weathering of mafic minerals leaves a slight pitting on the outcrop surface. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Olivine is anhedral and altered to iddingsite. The pyroxene is clinopyroxene and displays alteration to biotite and/or amphibole (?) along edges. Minor magnetite occurs in association with biotite. Perthite is stringy with minor patchy perthite. Some stringy perthite grains contain irregular areas of plagioclase (An 6?) with diffuse gradational boundaries into perthite.

Reference No. 991
Sample No. C24-18

Biotite, magnetite, amphibole, olivine, pyroxene syenite.

Field Description. Coarse grained, equigranular, massive. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Biotite is anhedral and commonly rims pyroxene. Magnetite forms minor, anhedral grains in association with amphibole and biotite. Dark brown, pleochroic amphibole forms rims on pyroxene. Clinopyroxene is colourless, anhedral, altering to biotite, amphibole, and magnetite. Weak schiller texture is present in some grains. Olivine forms anhedral grains, commonly altered to iddingsite. Plagioclase (albite-oligoclase) forms anhedral irregular grains interlocking with perthite. Large grains of stringy perthite contain angular to subangular grains of plagioclase. Perthite-perthite grain boundaries are lobate.

Reference No. 992
Sample No. C24-27

Biotite-bearing, olivine, amphibole, magnetite, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are pinkish-brown, fresh surfaces brownish-green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Olivine is anhedral, irregular with reddish-brown alteration to iddingsite. Biotite is anhedral and associated with amphibole and pyroxene. Amphibole forms dark greenish-brown grains in part mantling and replacing pyroxene. Apatite is euhedral, poikilitic in pyroxene. Clinopyroxene is colourless, mantled with amphibole and occurs in association with minor biotite and magnetite. Magnetite is anhedral, disseminated, and occurs in association with amphibole and biotite. Magnetite is likely an alteration product of pyroxene and olivine. Perthite grains are anhedral, forming an interlocking mosaic, with lobate grain boundaries. Some perthite grains are stringy and others are patchy.

Reference No. 993
Sample No. C24-28

Biotite-bearing, olivine, magnetite, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are pinkish-brown to pinkish-white, fresh surfaces brownish-green. Map-unit 6a.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Olivine forms anhedral grains often altered to iddingsite. Magnetite forms anhedral, disseminated grains commonly associated with pyroxene and amphibole. Amphibole is a dark greenish-brown and rims pyroxene. Minor biotite is associated with amphibole and magnetite. Clinopyroxene forms anhedral, colourless grains interlocking with feldspar. Pyroxene is altering to amphibole, and possibly magnetite. Plagioclase forms anhedral grains interlocking with perthite. Perthite is anhedral and forms an interlocking mosaic. Perthite has a stringy texture. Large grains may contain angular to subangular grains of plagioclase.

Reference No. 994
Sample No. C24-29

Magnetite, olivine, amphibole, pyroxene syenite.

Field Description. Medium grained, massive, equigranular. Weathered surfaces are pinkish-white, fresh surfaces brownish-green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Olivine forms anhedral grains in part altered to reddish-brown iddingsite. Minor biotite is an alteration product of olivine and pyroxene. Clinopyroxene is colourless, anhedral to subhedral, and often thickly mantled with amphibole and very minor biotite. Magnetite forms anhedral, irregular grains in association with amphibole and minor biotite, pyroxene and olivine. Amphibole forms dark greenish-brown rims on pyroxene and isolated grains likely after pyroxene. Perthite forms anhedral, interlocking mosaic of grains with curved to lobate grain boundaries and well developed stringy texture.

Reference No. 995
Sample No. C24-31

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, equigranular, massive. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (albite-oligioclase) forms anhedral to subhedral grains in part enclosed in perthite. Perthite forms anhedral grains with stringy texture. Perthite-perthite grain boundaries are lobate. Olivine forms anhedral grains altered to iddingsite, in close assocation with pyroxene. Pyroxene is a clinopyroxene often mantled with dark greenish-brown amphibole and minor biotite. Biotite rims magnetite. Magnetite, biotite, and amphibole are alteration products principally after pyroxene. Apatite is euhedral and poikilitic in pyroxene.

Reference No. 996
Sample No. C24-32

Olivine-bearing, pyroxene amphibole, biotite syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are buff to pinkish brown, fresh surfaces brownish-green. Some biotite is present and the outcrop displays a weak schistosity. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with lobate interdigitating grain boundaries. Olivine in association with pyroxene is commonly altered to iddingsite and traces of biotite. Biotite forms tabular, brown grains interlocking with and sometimes replacing amphibole. Amphibole is pleochroic, brown to dark brown and anhedral to ragged in outline. In part it replaces pyroxene but is likely primary in some instances. Amphibole replacing pyroxene commonly encloses anhedral magnetite grains. Pyroxene is colourless, anhedral and undergoing extensive alteration to amphibole, magnetite, and biotite. Pyroxene occurs as aggregate of grains. Stringy perthite forms anhedral grains with vestiges of albite twinning. Some large perthite grains are enveloped by an interlocking mosaic of anhedral, smaller perthite and plagioclase grains. Grain boundaries are lobate or interdigitating. Very minor myrmekite is present.

Reference No. 997
Sample No. C25-3

Magnetite, olivine, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are pinkish-white, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Olivine forms anhedral, irregular grains mostly altered to iddingsite. Disseminated magnetite forms anhedral, rounded grains in part an alteration product of pyroxene and olivine. Some magnetite is poikilitic in pyroxene. Amphibole occurs as dark greenish-brown, anhedral grains commonly rimming pyroxene. Minor actinolite is present. Pyroxene is a colourless clinopyroxene, anhedral in form, altering to amphibole and magnetite. Apatite occurs as poikilitic grains in pyroxene. Perthite forms anhedral, irregular grains with a stringy texture; grain boundaries are curved to lobate.

Reference No. 998
Sample No. C25-7

Olivine-bearing, biotite, pyroxene syenite.

Field Description. Medium to coarse grained, massive, equigranular. Minor biotite content imparts a weak schistosity to the rock. Fresh surfaces are green, weathered surfaces pinkish-white. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundries. Pyroxene is a colourless clinopyroxene, anhedral, and interlocking with feldspars. Apatite forms anhedral crystals poikilitic in pyroxene. Magnetite is disseminated in pyroxene and also occurs as isolated grains. Biotite forms anhedral grains commonly in association with magnetite. Olivine forms anhedral grains in part altered to iddingsite. Plagioclase (albite-oligoclase ?) forms anhedral, interlocking grains with curved grain boundaries. Perthite is stringy and interlocking with plagioclase grains.

Reference No. 999
Sample No. C25-11

Olivine-bearing, amphibole, pyroxene syenite.

Field Description. Medium to coarse grained, massive, equigranular, deeply weathered. Weathered surfaces are pinkish-white, fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Olivine occurs as rounded grains in association with pyroxene, altering to reddish-brown iddingsite and biotite. Pyroxene is anhedral to subhedral and rimmed with greenish amphibole. Occasional grains have oriented magnetite inclusions, i.e. schiller texture. Plagioclase (An 12?) forms anhedral grains interstitial to perthite and larger grains are undergoing replacement by potassium feldspar. Perthite forms anhedral, irregular grains with a stringy texture. It may enclose angular plagioclase fragments. Some antiperthite is present which appears to be a replacement of large plagioclase grains.

Reference No. 1000
Sample No. C34-1

Amphibole syenite.

Field Description. Coarse grained, massive, equigranular. Fresh surfaces are yellow brown, weathered surfaces brown. Outcrop in centre of Bennet Creek. Map-unit 6b.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with straight to lobate grain boundaries. Amphibole is pleochroic in brown to dark brown; crystals are anhedral and ragged. Plagioclase occurs as angular fragments in perthite and as large grains with patch perthite. Crystals are offset and fractured and the texture is protoclastic. Angular fragments in perthite may have several orientations, or are random; crystals are fractured along cleavage planes. Perthite is anhedral and appears to be a very fine grained perthite on which a coarser grained perthite has developed. Coarse perthite strings are oriented normal to long axis of some grains and/or roughly normal to grain margins in others.

Reference No. 1001
Sample No. C37-1

Amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown to reddish-brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, inequiganular-seriate, allotriomorphic, with curved to lobate grain boundaries. Apatite forms anhedral to subhedral, rounded to rounded-elongate grains poikilitic in pyroxene and amphibole. Olivine is present in trace amounts and is altered to iddingsite. Pyroxene is colourless, anhedral, rounded in outline and occurs as aggregates of grains. It is extensively altered to amphibole and magnetite. Amphibole is pleochroic in brown to greenish-brown; it locally encloses anhedral magnetite and replaces pyroxene. Smaller plagioclase (An 28-30) grains form an interlocking mosaic with perthite, enclosing somewhat larger perthite grains. Perthite is stringy and may enclose vestiges of plagioclase. Some patch antiperthite is present.

Reference No. 1002
Sample No. C37-2

Olivine and biotite-bearing, amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are reddish-brown, fresh surfaces green with faint mottling of brown. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive inequigranular-seriate, allotriomorphic, with curved to lobate grain boundaries. Olivine forms rounded grains, generally altered to iddingsite, and may contain poikilitic apatite. Also, it is rarely altered to amphibole; usually alteration is to biotite. Pyroxene forms clear, rounded grains, undergoing extensive alteration to amphibole. Amphibole forms anhedral, irregular grains mantling pyroxene. Crystals are pleochroic in brown to greenish-brown. Magnetite forms anhedral grains enclosed in amphibole. Amphibole and magnetite are after pyroxene. Biotite is minor, forming tabular grains in

association with pyroxene and possibly altering from amphibole. Plagioclase forms anhedral grains, sometimes occurring in perthite. Some plagioclase is replaced by potassium feldspar. Perthite a string perthite which may contain angular to irregular grains of plagioclase. Some grains have cuspate grain margins implying replacement of plagioclase by potassium feldspar. Some off-setting of albite twinning implies a protoclastic texture. Some patch antiperthite is present.

Reference No. 1003
Sample No. C37-4

Olivine-bearing, biotite, pyroxene, amphibole syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces brownish-green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with lobate grain boundaries. Grain boundaries are strongly interdigitating. Apatite is anhedral to subhedral, poikilitic in pyroxene and amphibole, occurring as small elongate rods. Magnetite forms anhedral grains enclosed in amphibole and associated with biotite. Amphibole is pleochroic in brown to dark brown, anhedral to ragged, replaces pyroxene and may be in part primary. Often it contains anhedral poikilitic magnetite. Biotite forms tabular, anhedral grains interlocking with pyroxene and amphibole, occasionally olivine. Olivine forms rounded grains partially enclosed in pyroxene, some altering to iddingsite. Dark alteration occcurs along curved fractures. Plagioclase (An 37?) forms anhedral grains often enclosed within perthite. Perthite is stringy and grain boundaries are lobate to interdigitating; it may contain vestiges of plagioclase.

Reference No. 1004
Sample No. C37-5

Amphibole, pyroxene, biotite syenite.

Field Description. Coarse grained. Weathered surfaces are brown, fresh surfaces yellow brown. Biotite forms large poikioblastic appearing grains up to several centimetres in diameter. Biotite imparts a weak schistosity to the outcrop. Map-unit 6b.

Petrographic Description. Fine to medium grained, equigranular, allotriomorphic, with straight to lobate grain boundaries. Apatite forms anhedral to euhedral crystals poikilitic in pyroxene, amphibole, and biotite. Some crystals are rod-shaped. Pyroxene forms rounded, anhedral, colourless grains being replaced by biotite, amphibole and magnetite. Amphibole is anhedral, pleochroic in dark brown to reddish-brown, interlocking with pyroxene and biotite, and with magnetite may result from the breakdown of pyroxene. Biotite forms brown, tabular crystals interlocking with amphibole and pyroxene. It may result from the breakdown of both amphibole and pyroxene. Magnetite is poikilitic in both amphibole and biotite, anhedral, and likely results from the breakdown of pyroxene and perhaps amphibole. Plagioclase (An 28?) forms anhedral, irregular grains, interlocking with each other along relatively straight boundaries. Boundaries with perthite are commonly curved to cuspate. Perthite forms anhedral, irregular grains with lobate grain boundaries, and may enclose angular plagioclase inclusions and vestiges of plagioclase.

Reference No. 1005
Sample No. C37-6A

Metamorphosed biotite gabbro.

Field Description. Fine to medium grained, massive, equigranular. The rock forms a large inclusion in coarse-grained syenite. The inclusion is veined with two ages of syenite. Weathered and fresh surfaces are grey-black. Inclusion has a pitted weathered surface with individual pits up to 4 mm in diameter. Contact of block and syenite is sharp. The block is clearly cut by coarse-grained syenite which is then cut by a fine-grained aplitic syenite. Map-unit 5a.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Plagioclase phenocrysts (An 44-52) are subhedral in form and glomeroporphyritic. It may contain poikilitic, anhedral pyroxene, generally fresh. Several small biotite grains are also poikilitic in the plagioclase. Variable extinction of plagioclase suggests grains are zoned with albite twinning more diffuse towards the grain margins. Plagioclase of groundmass is anhedral and interlocking with biotite and pyroxene. Clinopyroxene forms rounded to subangular grains interstitial to plagioclase. Clinopyroxene contains poikilitic inclusions of plagioclase and biotite. Biotite forms tabular, pleochroic, brown to light brown to dark brown grains interlocking with pyroxene and plagioclase. Rod-like crystals of apatite are relatively small and poikilitic in plagioclase, pyroxene and biotite.

Reference No. 1006
Sample No. C39-1

Pyroxene-bearing, amphibole syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces medium to light yellow brown. Texture is slightly finer-grained on north side of outcrop. Map-unit 6k.

Petrographic Description. Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic with lobate grain boundaries to granoblastic with curved grain boundaries. Amphibole is pleochroic, brown to greenish-brown, anhedral, and may contain poikilitic apatite, magnetite, and relict pyroxene. Some amphibole may be primary rather than from pyroxene breakdown. Pyroxene forms rounded, anhedral grains and commonly is present as relicts in amphibole. Magnetite is minor and poikilitic in amphibole. Apatite occurs as small crystals, poikilitic in amphibole. Some crystals are rod-like. Plagioclase (An 28-30) forms anhedral crystals, commonly as smaller grains interlocking with smaller perthite grains. Interlocking grains form a mosaic enclosing larger perthite grains. Perthite is stringy, anhedral in form with lobate grain boundaries. Vestiges of plagioclase are present and visual offset of twin planes across areas of replacement implies former protoclastic texture in plagioclase.

Reference No. 1007
Sample No. C39-4A

Amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces medium yellow brown with green mottling. Two fractures showed dark alteration (they were removed from the sample before analysis). The coarse-grained syenite contains the occasional inclusion of aplitic syenite. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to lobate boundaries. Pyroxene forms clear, rounded grains, generally mantled with amphibole or occurring as relicts in amphibole. Magnetite is anhedral, occurring as relatively small grains poikilitic in amphibole. Amphibole is pleochroic in brown and dark brown, in part after pyroxene but some may be primary. Plagioclase (An 28-32) forms anhedral grains interlocking with some perthite grains. Larger grains are undergoing replacement by potassium feldspar. One larger grain may contain poikilitic biotite and pyroxene. Perthite is stringy with vestiges of albite twinning. Some patchy antiperthite is present. Grain boundaries are lobate.

Reference No. 1008
Sample No. C40-5

Pyroxene syenite.

Field Description. Fine grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. The rock may be a chilled phase of the green, medium- to coarse-grained phase. Map-unit 6e.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Pyroxene is a clinopyroxene with irregular to rounded forms. Perthite is anhedral with stringy texture. Perthite has lobate grain boundaries. Possibly a chilled contact phase.

Reference No. 1009
Sample No. C49-1

Amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to medium grained, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Apatite is anhedral to euhedral, poikilitic in pyroxene and amphibole. Pyroxene is a colourless clinopyroxene occurring as aggregates of several crystals. Crystals are anhedral to subhedral, commonly associated with magnetite, and may poikilitically enclose small apatite and magnetite grains. Amphibole is pleochroic brown to greenish-brown, and mantles or replaces some pyroxene grains. Perthite forms anhedral to subhedral grains with a stringy texture. Stringy areas are separated by clear areas which visually appear to be non-perthitic. Small, anhedral to euhedral pyroxene grains and several amphibole grains are poikilitically enclosed. Magnetite is anhedral, interlocking with pyroxene and poikilitic in amphibole. Magnetite is in part primary, in part the product of pyroxene breakdown.

Reference No. 1010
Sample No. C49-5

Biotite, amphibole and olivine-bearing, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown; fresh surfaces green. Map-unit 6a.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with lobate grain boundaries. Olivine forms anhedral grains with dark brown alteration along curved cracks, and is commonly associated with pyroxene. Olivine is altered to iddingsite and occasionally biotite. Pyroxene is a clear, colourless clinopyroxene, anhedral in form, altering to amphibole and biotite. Magnetite is anhedral and an alteration product of amphibole and pyroxene. Biotite forms brown, tabular crystals commonly from olivine. Amphibole forms pleochroic brown to greenish-brown rims on pyroxene, and is closely associated with magnetite. Plagioclase forms anhedral grains interlocking with lobate grain boundaries. Abundant vestiges of plagioclase occur in some grains of patch antiperthite.

Reference No. 1011
Sample No. C51-2

Biotite, pyroxene syenodiorite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are yellow-brown, fresh surfaces greenish-brown. Map-unit 6k.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Apatite forms anhedral to euhedral crystals, poikilitic in pyroxene and biotite. Minor olivine forms rounded grains altered to reddish-brown iddingsite in close association with pyroxene. Biotite forms tabular, brown grains in association with pyroxene. Grains are somewhat ragged along edges normal to cleavage. Magnetite forms anhedral grains poikilitic in pyroxene and in some cases poikilitic in biotite. Magnetite is partially primary and partially derived from breakdown of pyroxene. Pyroxene is a colourless clinopyroxene anhedral in form with alteration to biotite and magnetite. Anhedral grains of plagioclase (An 28?) form an interlocking mosaic. Plagioclase appears fresh and unstressed. Stringy perthite forms anhedral grains partially replacing plagioclase in irregular amoeboid-like fashion and also as large grains enclosing plagioclase.

Reference No. 1012
Sample No. C51-3

Amphibole, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are rusty brown, fresh surfaces green. Map-unit 6a.

Petrographic Description. Medium to coarse grained, massive, inequigranular-seriate, allotriomorphic, with lobate to serrate grain boundaries. Perthite forms an interlocking mosaic of anhedral grains with serrate to lobate grain boundaries. Myrmekite forms anhedral grains somewhat smaller than perthite grains. Myrmekite-like textures appear to be intergrowths of potassium feldspar and plagioclase. Clinopyroxene is a colourless to very pale green anhedral mineral, occurring in aggregates and altering to amphibole, biotite and magnetite. Amphibole is a dark brown to reddish-brown and may result from pyroxene breakdown. Olivine forms rounded grains enclosed in amphibole and completely altered to reddish-brown iddingsite. Olivine content is very minor. Very minor biotite forms anhedral grains on margins of several pyroxene grains. Magnetite is associated with biotite and amphibole and is likely the product of pyroxene breakdown. Apatite is subhedral, prismatic, poikilitic in pyroxene and its alteration products.

Reference No. 1013
Sample No. C51-4C

Olivine and amphibole-bearing, pyroxene syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are brown, fresh surfaces green. The rock contains rare inclusions of fine-grained aplitic syenite. The outcrop is cut by two dikes, one syenite aplite and the other a fine-grained mafic dike. The sample for analysis was taken 150 feet south of the exposure with dikes and occasional inclusion. Map-unit 6a.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with lobate to serrate grain boundaries. Olivine forms rounded grains commonly altered to iddingsite, and closely associated with pyroxene. Biotite occurs in trace amounts with magnetite. Apatite forms anhedral to euhedral crystals poikilitic in pyroxene and olivine. Colourless clinopyroxene occurs as anhedral grains interlocking with feldspars. Amphibole is pleochroic, brown to greenish-

brown and rims some pyroxenes. Amphibole is after pyroxene. Magnetite is anhedral and poikilitic in pyroxene and amphibole. Magnetite poikilitic in biotite may have resulted from pyroxene breakdown. Plagioclase occurs with diffuse twin planes implying former protoclastic texture. Perthite forms anhedral grains with local ghost-like vestiges of plagioclase. Stringy perthite has lobate to serrate grain boundaries.

Reference No. 1014
Sample No. C60-2B

Pyroxene, biotite, amphibole syenodiorite.

Field Description. Coarse grained, massive, inequigranular-seriate. Large grains of biotite up to 2 cm in diameter appear poikioblastic. Weathered surfaces are rusty brown, fresh surfaces green. Map-unit 6k.

Petrographic Description. Fine to medium grained, inequigranular-seriate, allotriomorphic, microporphyroblastic, granoblastic, with curved to serrate grain boundaries. The rock is metamorphosed. Plagioclase (An 40) forms ragged, anhedral crystals. Variation in extinction across crystal suggests compositional zoning. Plagioclase grains occur in clusters. Olivine is very minor and has dark alteration along curved fractures. Amphibole is porphyroblastic, pleochroic in brown to reddish-brown, anhedral to subhedral, and contains rounded blebs of plagioclase and perthite. Biotite forms anhedral, ragged grains and is also poikioblastic, containing magnetite, plagioclase, perthite and olivine (?). Some small grains occur as aggregates in association with pyroxene and magnetite. Pyroxene is anhedral, colourless and may contain poikilitic magnetite. The clinopyroxene is altering to amphibole, biotite and magnetite. The magnetite occurs as anhedral crystals poikilitic in pyroxene, amphibole and biotite. Anhedral grains of perthite form an interlocking mosaic. Perthite grains are generally smaller than plagioclase grains and have well developed stringy texture.

Reference No. 1015
Sample No. CH28-698.4' (drill core sample)

Feldspar-bearing metapyroxenite.

Fine grained, massive, equigranular, allotriomorphic, granoblastic, with curved to straight grain boundaries. Amphibole is dark green and anhedral. Very fine-grained, myrmekite-like intergrowths are possibly amphibole and feldspar. Some epidote may also be present. Apatite occurs as rounded, bead-like grains. Carbonate occurs as anhedral grains. Pyroxene is a dark green clinopyroxene, aegirine-augite, forming rounded grains in association with amphibole. Feldspars are anhedral and form an interlocking and granoblastic mosaic. Feldspar contains poikilitic amphibole and pyroxene.

Reference No. 1016
Sample No. CH28-755.9' (drill core sample)

Feldspar-bearing metapyroxenite.

Fine grained, massive, equigranular, allotriomorphic, granoblastic, with curved to straight grain boundaries. Myrmekite-like textures occur in turbid areas of fine-grained intergrowths of feldspar, amphibole, and possibly epidote. Minor, anhedral interstitial carbonate. Feldspar forms anhedral clear grains. Feldspar may poikilitically enclose pyroxene and amphibole. Apatite forms anhedral, rounded grains. Pyroxene is a dark green clinopyroxene, aegirine-augite. It is anhedral and forms rounded grains. Amphibole is a green anhedral mineral.

Reference No. 1017
Sample No. CH29-67.2' (drill core sample)

Biotite, pyroxene, amphibole syenite.

Medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is a colourless clinopyroxene mantled with amphibole, biotite and magnetite. Some grains display a patchy alteration to amphibole and biotite. Plagioclase (An 10) forms anhedral grains interlocking with other plagioclases and perthite. Perthite is of patch and stringy type. Patch perthite is an antiperthite. The boundary between the two types is interpenetrating lobate. Offset of albite twin planes in some grains implies a protoclastic texture in plagioclase. Amphibole is dark greenish-brown and mantles pyroxene. Biotite also mantles pyroxene and occurs as inclusions within amphibole. Magnetite occurs in association with amphibole and biotite; all three are likely the result of alteration of the pyroxene.

Reference No. 1018
Sample No. CH29-93.0' (drill core sample)

Biotite, amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Amphibole is a greenish-brown, ragged in outline, interlocking with biotite. Biotite forms an-

hedral grains in association with amphibole. Small inclusions with dark haloes are probably zircons with radioactive decay bombardment haloes. Plagioclase (An 2–8) forms anhedral, irregular grains interlocking with other plagioclase grains and perthite. Perthite forms anhedral grains with well developed stringy texture. Perthite grains have lobate grain boundaries.

Reference No. 1019
Sample No. CH29-245.5' (drill core sample)

Olivine-bearing, magnetite, amphibole, pyroxene syenite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Olivine, partly altered to iddingsite, occurs in anhedral grains. Clinopyroxene is a colourless, anhedral mineral; some grains have a schiller texture. Magnetite is anhedral and found in association with amphibole. Amphibole is dark greenish-brown and rims pyroxene. Amphibole is sometimes closely associated with magnetite and may enclose perthite grains. Stringy perthite forms an interlocking mosaic of anhedral grains. Perthite-perthite grain boundaries are both curved and lobate.

Reference No. 1020
Sample No. CH29-317.5' (drill core sample)

Amphibole, quartz syenite.

Fine grained, equigranular, massive, allotriomorphic, with curved to lobate grain boundaries. Quartz is anhedral, interstitial. Amphibole forms ragged, anhedral, dark greenish-brown grains. It may contain some anhedral, poikilitic magnetite. Plagioclase (albite-oligoclase) forms anhedral, irregular grains interlocking with other plagioclase and perthite. Perthite forms an anhedral, interlocking mosaic of grains with stringy texture. Perthite-perthite grain boundaries are lobate.

Reference No. 1021
Sample No. CH29-328.4' (drill core sample)

Amphibole, pyroxene syenite.

Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene is a clinopyroxene thickly mantled with amphibole. Pyroxene is somewhat turbid. Amphibole is dark greenish-brown and often contains relict pyroxene cores. Minor magnetite occurs in association with amphibole. Plagioclase (An 9) forms anhedral, irregular grains interlocking with perthite and other plagioclase grains. Perthite is anhedral with a coarse stringy texture. Patch perthite is common and appears to be plagioclase undergoing replacement by potassium feldspar. Perthite-perthite grain boundaries are lobate. Traces of altered olivine with minor accessory apatite are present.

Reference No. 1022
Sample No. CH29-548.0' (drill core sample)

Biotite, amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, granoblastic, with straight to curved grain boundaries. Minor, anhedral, rounded blebs of carbonate are present. Biotite forms irregular, ragged grains which may poikilitically enclose amphibole. Amphibole is dark greenish-brown, anhedral, and may occur as poikilitic inclusions in feldspar. There are relatively large patches of very fine-grained saussurite. Feldspars are irregular, clear, and form an interlocking mosaic of grains with good granoblastic texture. Feldspar is possibly anorthoclase. It poikilitically encloses amphibole. Some irregular grains with a worm-eaten appearance may be fine-grained nepheline-feldspar intergrowths. Some myrmekite is present which may be a very fine intergrowth of amphibole and feldspar. The rock resulted from recrystallization i.e. contact metamorphism.

Reference No. 1023
Sample No. CH29-574.3' (drill core sample)

Altered amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, with lobate to serrate grain boundaries. Amphibole (?) is altered to a turbid nearly isotropic mass. Some reddish-brown alteration is closely associated. Amphibole is interstitial to feldspar. Feldspar is an anhedral perthite with a coarse stringy texture. Feldspar is fresh and displays lobate to serrate feldspar-feldspar grain boundaries.

Reference No. 1024
Sample No. CH29-602.0' (drill core sample)

Amphibole quartz syenite.

Fine grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Amphibole forms ragged, sometimes turbid grains of dark green colour. Amphibole is partially

altered. Plagioclase (An 2-8) forms anhedral, interlocking grains. Plagioclase occurs as aggregates of small grains along margins of larger perthite grains. String perthite forms larger, anhedral grains. Quartz forms anhedral grains throughout, forming a mesh-like network isolating island-like aggregates of perthite and plagioclase.

Reference No. 1025
Sample No. CH29-649.5' (drill core sample)

Amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, granoblastic, with curved to straight grain boundaries. Carbonate forms anhedral, irregular, interstitial grains. Patchy, very fine-grained saussurite occurs throughout. Amphibole is greenish-brown, anhedral, and forms an interlocking mosaic of grains. At low magnification grains are somewhat bead-like. Traces of myrmekite-like textures consist of very fine-grained intergrown amphibole and feldspar. Minor brown anhedral biotite and traces of accessory apatite and fluorite are present. Feldspar occurs as an interlocking mosaic of anhedral grains. Larger grains contain poorly defined rings of amphibole inclusions.

Reference No. 1026
Sample No. CH29-679.8' (drill core sample)

Silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Magnetite forms anhedral, disseminated grains. Biotite is brown, anhedral and scattered throughout. Biotite is somewhat clotty and some grains have bent (001) cleavage. Apatite forms rounded, bead-like and often elongate grains. Pyroxene is a pale green clinopyroxene forming rounded, anhedral grains. Pyroxene rarely encloses a bleb of carbonate or grain of magnetite.

Reference No. 1027
Sample No. CH29-803.0' (drill core sample)

Amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Minor, anhedral, disseminated magnetite is associated with amphibole. Amphibole is brownish-green, anhedral, interstitial to feldspar. Perthite forms an interlocking mosaic of anhedral grains. Stringy perthite is coarse. Perthite-perthite grain boundaries are curved to lobate. Traces of olivine are altered to iddingsite.

Reference No. 1028
Sample No. CH29-845.8' (drill core sample)

Pyroxene, biotite silicocarbonatite.

Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Biotite forms anhedral, brown grains. Several grains have bent (001) cleavages. Magnetite is anhedral and disseminated. Pyroxene is a clinopyroxene, aegirine-augite. Pyroxene is anhedral and may enclose blebs of carbonate. Traces of iddingsite are after olivine. Albite forms narrow, clear, untwinned rims on some biotite and pyroxene grains. Carbonate forms an interlocking mosaic of anhedral grains. Apatite forms anhedral, often elongate grains.

Reference No. 1029
Sample No. CH29-864.7' (drill core sample)

Metapyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Magnetite is anhedral, disseminated, poikilitic in amphibole. Dark green amphibole forms relatively large grains with poikilitic magnetite, carbonate, and pyroxene. Clinopyroxene forms rounded, anhedral grains, and is green to pale green in colour. Pyroxene is possibly aegirine-augite. Minor feldspar is present, possibly anorthoclase. Carbonate forms anhedral, interstitial grains. Trace to minor amounts of apatite are present.

Reference No. 1030
Sample No. CH29-888.0' (drill core sample)

Pyroxene, biotite silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite forms anhedral, brown grains. Pyroxene is a clinopyroxene, somewhat turbid, very faintly pale green. Aegirine content is likely low. Carbonate forms an interlocking mosaic of anhedral grains. Magnetite is anhedral, disseminated. Apatite forms anhedral, often elongated grains.

Reference No. 1031
Sample No. CH30-99.9' (drill core sample)

Pyroxene, biotite syenite.

Fine grained, equigranular, massive, allotriomorphic, with curved to lobate grain boundaries. Apatite is anhedral to subhedral commonly associated with biotite and pyroxene. Clinopyroxene forms rounded anhedral grains, very pale green, it does not likely contain much aegirine-augite. Biotite forms brown, anhedral grains, and may have magnetite within the cores of some grains. Perthite is anhedral, forming an interlocking mosaic of grains with a stringy texture. Perthite-perthite grain boundaries are curved to lobate.

Reference No. 1032
Sample No. CH30-116.8' (drill core sample)

Amphibole syenite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Amphibole is a dark brownish-green and anhedral. Stringy perthite forms an interlocking mosaic of anhedral, coarse grains. There are traces of patchy perthite.

Reference No. 1033
Sample No. CH30-149.0' (drill core sample)

Biotite-bearing, amphibole, pyroxene syenite.

Medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Pyroxene is dark green aegirine-augite, anhedral, with occasional poikilitic apatite. Amphibole is dark greenish-brown, anhedral, and commonly rims pyroxene. Magnetite ocurs in association with biotite and amphibole. Minor biotite is associated with amphibole. Plagioclase (An 13) forms anhedral grains. Perthite forms an interlocking mosaic of anhedral grains. There are clear, narrow rims of albite on some perthite grains. Well developed patch perthite is present and could be classified as antiperthite. Drill core sample is light in colour.

Reference No. 1034
Sample No. CH30-166.5' (drill core sample)

Quartz-bearing, amphibole, pyroxene syenite.

Medium grained, massive, equigranular, allotriomorphic, with curved to serrate grain boundaries. Pyroxene is a colourless to very pale green clinopyroxene, often mantled with amphibole. Amphibole is a dark greenish-brown, often mantling pyroxene. Minor magnetite occurs in association with amphibole. Minor, anhedral, interstitial quartz is present. Perthite forms an interlocking mosaic of anhedral grains with lobate to serrate grain boundaries. Some perthite grains have narrow rims of albite.

Reference No. 1035
Sample No. CH30-196.5' (drill core sample)

Apatite, magnetite, pyroxene sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Trace amounts of olivine are altered to a deep reddish-brown iddingsite. Magnetite forms anhedral, disseminated grains. Pyroxene is a clinopyroxene, pale green to green, anhedral in form. It may poikilitically contain carbonate and apatite. Pyroxene is aegirine-augite. Apatite is anhedral, rounded to elongate-rounded in form. Carbonate grains forms an anhedral, interlocking mosaic.

Reference No. 1036
Sample No. CH30-408.1' (drill core sample)

Pyroxene syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene is anhedral, irregular, dark green aegirine-augite. Plagioclase is a minor component marginal to relatively larger perthite grains. Perthite forms an interlocking mosaic of grains with well developed stringy texture. Perthite grain boundaries are curved to lobate.

Reference No. 1037
Sample No. CH30-451.5' (drill core sample)

Pyroxene syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Minor plagioclase occurs along borders of perthite grains with well developed stringy texture. They form an interlocking mosaic with lobate grain boundaries. Pyroxene is an anhedral, green to dark green aegirine-augite. Some Carlsbad twinning is present in perthite.

Minor anhedral magnetite is in close association with pyroxene and some grains have a very narrow rim of sphene (?). Scattered grains of patch perthite may be antiperthite.

Reference No. 1038
Sample No. CH30-549.8' (drill core sample)

Amphibole, pyroxene syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Plagioclase (An 11?) forms anhedral grains, sometimes in aggregates marginal to the somewhat larger perthite grains. Narrow clear albite rims occur on some of the larger perthite grains. Apatite is subhedral, poikilitic in pyroxene and amphibole. Amphibole forms anhedral grains interlocking with pyroxene. Amphibole is dark brownish-green. Amphibole encloses pyroxene, sphene and apatite. Pyroxene is an aegirine-augite, green in colour, commonly as relicts thickly mantled with or interlocking with amphibole. Perthite forms an anhedral interlocking mosaic of grains with a coarse stringy texture.

Reference No. 1039
Sample No. CH30-600.3' (drill core sample)

Pyroxene syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. Pyroxene is anhedral, dark green aegirine-augite. Minor anhedral magnetite occurs along margins of pyroxene and poikilitic within pyroxene. Perthite has well developed stringy texture; large grains have Carlsbad twinning. Grain boundaries are curved to lobate. Minor, clear, colourless plagioclase rims some perthite grains. A number of grains of patch perthite could be classified as antiperthite.

Reference No. 1040
Sample No. CH30-652.5' (drill core sample)

Apatite, pyroxene, magnetite silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Apatite forms anhedral, rounded to elongated grains. Magnetite forms anhedral, disseminated grains and may enclose pyroxene. Traces of pyrochlore occur within magnetite and along edges of magnetite grains. Carbonate forms an interlocking mosaic of anhedral grains. Pyroxene is an anhedral pale green aegirine-augite, and locally is partially enclosed in magnetite.

Reference No. 1041
Sample No. CH102-258.3' (drill core sample)

Biotite, pyroxene syenite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Rock tends to be somewhat granoblastic. Biotite forms an anhedral, interlocking mass of brown grains. Pyroxene is a green aegirine-augite and commonly occurs as anhedral, irregular, bead-like grains. Feldspar is probably anorthoclase, forming optically continuous grains which are amoeboid and have pyroxene inclusions. Rock has a recrystallized or metamorphic texture.

Reference No. 1042
Sample No. CH102-470.9' (drill core sample)

Biotite, magnetite, pyroxene syenite.

Fine grained, massive, inequigranular-seriate, allotriomorphic, with areas of granoblastic texture. Abundant, fine-grained, disseminated magnetite forms an irregular mesh in association with fine-grained, granoblastic feldspar that isolates areas of coarser grained perthite. Disseminated magnetite also rims and outlines some perthite grains. Perthite is stringy, anhedral, and displays occasional Carlsbad twinning. Biotite forms anhedral, irregular grains in association with magnetite and pyroxene. Magnetite is poikilitic in biotite. Pyroxene is associated with magnetite and biotite. Pyroxene is an anhedral, dark green aegirine-augite, interlocking with biotite and magnetite. The rock has likely undergone considerable addition of iron.

Reference No. 1043
Sample No. CH104-317.0' (drill core sample)

Biotite, pyroxene syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to serrate grain boundaries. Apatite forms anhedral to euhedral grains, poikilitic in pyroxene. Biotite forms reddish-brown grains along rims of pyroxene and magnetite grains. Minor, anhedral, disseminated magnetite is present. Amphibole is dark green, anhedral, possibly with some relict pyroxene cleavage. The rock contains minor, interstitial carbonate. Perthite forms anhedral,

irregular mosaic of interlocking grains. Perthite has a stringy texture. Perthite–perthite grain boundaries are lobate to serrate. Minor patchy perthite is present and could be antiperthite.

Reference No. 1044
Sample No. CH104–490.8' (drill core sample)

Amphibole syenite.

Fine to medium grained, massive, inequigranular–seriate, allotriomorphic, with curved grain boundaries. Minor, disseminated magnetite is associated with amphibole and enclosed within amphibole. Amphibole is dark green, anhedral, and interlocking with feldspar. Carbonate is minor and occurs as anhedral, interstitial grains. Smaller feldspar grains are clear and form a moderately well developed granoblastic texture. Larger feldspar grains are stringy perthites and interlock with smaller clear feldspars. Some Carlsbad twinning is present in perthites. Feldspar texture suggests incomplete homogenization of a typical syenite feldspar.

TABLE A-2. MAJOR ELEMENT ANALYSES (WEIGHT PERCENT) OF WHOLE-ROCK SAMPLES FROM THE CLAY-HOWELLS ALKALIC ROCK COMPLEX.

	Unit 6a						
Ref. No.	**956**	**964**	**965**	**966**	**967**	**968**	**969**
SiO_2	63.8	58.9	57.6	60.3	58.8	61.9	57.40
Al_2O_3	15.5	15.2	15.8	17.6	17.0	18.7	16.1
Fe_2O_3	1.59	1.71	2.56	1.27	2.68	1.09	2.40
FeO	3.99	7.55	5.66	3.99	4.41	1.68	5.39
MgO	0.06	1.48	1.26	0.56	0.81	0.20	0.98
CaO	1.52	2.70	3.28	2.64	2.80	1.71	3.07
Na_2O	5.48	5.42	5.33	5.41	4.98	5.65	4.92
K_2O	5.73	5.53	5.43	6.12	6.24	6.99	6.06
TiO_2	0.41	0.75	1.19	0.64	0.96	0.69	1.18
P_2O_5	0.05	0.13	0.40	0.21	0.27	0.16	0.36
S	0.02	0.04	0.05	0.03	0.03	<0.01	0.04
MnO	0.16	0.35	0.23	0.16	0.19	0.06	0.21
CO_2	0.10	0.21	0.12	0.18	0.22	0.15	0.26
H_2O+	0.59	0.04	0.29	0.33	0.35	0.06	0.09
H_2O-	0.21	0.24	0.21	0.17	0.19	0.31	0.36
Total	99.20	99.30	99.40	99.60	99.90	99.40	98.80

	Unit 6a						
Ref. No.	**970**	**971**	**972**	**973**	**974**	**975**	**976**
SiO_2	58.2	58.48	59.4	60.6	60.1	56.6	59.77
Al_2O_3	17.2	18.14	19.46	18.0	17.5	19.32	17.43
Fe_2O_3	2.76	2.01	1.73	1.95	1.93	1.76	2.39
FeO	3.84	3.62	2.42	3.08	3.78	3.46	4.19
MgO	0.63	0.50	0.34	0.51	0.61	0.97	0.61
CaO	3.09	2.39	2.42	2.45	2.35	3.36	2.47
Na_2O	5.53	5.06	5.19	5.59	5.38	4.58	5.14
K_2O	5.53	5.89	5.85	5.87	5.77	5.87	5.68
TiO_2	1.00	0.74	0.45	0.63	0.77	1.15	0.82
P_2O_5	0.30	0.17	0.17	0.20	0.22	0.36	0.18
S	0.03	0.03	0.04	0.02	0.02	0.04	0.03
MnO	0.18	0.16	0.12	0.14	0.17	0.11	0.21
CO_2	0.17	0.75	0.77	0.16	0.13	0.54	0.52
H_2O+	0.07	0.25	0.26	0.23	0.32	0.30	0.12
H_2O-	0.22	0.22	0.20	0.19	0.21	0.28	0.28
Total	98.80	98.40	98.80	99.60	99.30	98.70	99.80

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
956	C6-5	970	C21-2
964	C20-8B	971	C22-5
965	C20-12A	972	C22-9
966	C20-17	973	C23-2
967	C20-25	974	C23-5
968	C20-30	975	C23-8
969	C20-30B	976	C23-10

TABLE A-2. CONTINUED.

	Unit 6a						
Ref. No.	978	979	980	981	982	983	984
SiO_2	58.17	58.67	60.57	58.54	59.53	60.34	58.39
Al_2O_3	17.34	18.46	19.0	18.91	19.26	18.77	17.46
Fe_2O_3	2.39	1.66	1.64	1.64	1.35	1.61	2.76
FeO	4.67	3.94	2.33	3.54	3.94	3.15	5.31
MgO	0.78	0.87	0.33	0.67	0.67	0.41	0.71
CaO	2.94	3.00	1.90	2.90	2.91	2.34	3.09
Na_2O	4.90	5.24	5.26	5.29	5.23	5.47	4.77
K_2O	5.45	5.70	6.50	5.46	5.40	6.17	5.84
TiO_2	0.95	0.82	0.52	0.78	0.80	0.66	0.97
P_2O_5	0.26	0.25	0.08	0.21	0.22	0.17	0.35
S	0.05	0.04	0.02	0.03	0.04	0.03	0.04
MnO	0.19	0.15	0.12	0.14	0.16	0.15	0.25
CO_2	0.58	0.53	0.66	0.74	0.86	0.67	0.64
H_2O+	0.30	0.18	0.21	0.28	0.28	0.16	0.23
H_2O-	0.23	0.21	0.24	0.23	0.24	0.23	0.22
Total	99.20	99.70	99.40	99.40	100.90	100.30	100.80

	Unit 6a						
Ref. No.	985	986	987	988	989	990	991
SiO_2	59.3	61.2	59.7	60.8	59.1	61.3	60.6
Al_2O_3	16.3	16.0	16.3	16.9	16.4	18.0	17.1
Fe_2O_3	2.29	1.93	2.56	1.56	2.20	1.86	1.94
FeO	5.10	4.76	5.39	4.20	5.04	2.44	3.84
MgO	0.93	0.44	0.58	0.51	0.71	0.37	0.57
CaO	2.99	2.39	2.73	2.10	2.67	1.84	2.11
Na_2O	4.94	4.81	4.81	4.67	4.82	5.21	5.03
K_2O	5.58	5.95	6.04	6.25	6.06	6.88	6.88
TiO_2	1.04	0.70	0.80	0.61	1.00	0.80	0.81
P_2O_5	0.30	0.17	0.19	0.15	0.26	0.24	0.12
S	0.05	0.03	0.01	0.03	0.04	0.02	0.03
MnO	0.22	0.22	0.28	0.18	0.26	0.09	0.15
CO_2	0.10	0.13	0.13	0.10	0.28	0.37	0.22
H_2O+	0.14	0.26	0.26	0.24	0.18	0.44	0.43
H_2O-	0.23	0.29	0.29	0.27	0.23	0.23	0.25
Total	99.50	99.40	100.10	98.60	99.30	100.10	99.80

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
978	C23-13	985	C24-1B
979	C23-17	986	C24-3
980	C23-20	987	C24-4
981	C23-26	988	C24-5
982	C23-28	989	C24-9
983	C23-29	990	C24-17
984	C23-31	991	C24-18

TABLE A-1 CONTINUED.

	Unit 6a						
Ref. No.	**992**	**993**	**994**	**995**	**996**	**997**	**998**
SiO_2	60.2	60.2	60.0	60.8	58.16	60.3	58.0
Al_2O_3	17.6	17.2	17.2	17.7	18.73	17.1	16.3
Fe_2O_3	1.30	1.68	2.56	2.12	1.59	2.16	2.47
FeO	3.99	3.84	3.50	3.01	4.27	3.50	5.39
MgO	0.71	0.58	0.69	0.61	0.94	0.53	1.33
CaO	2.74	2.51	2.56	2.54	2.95	2.54	3.70
Na_2O	5.50	5.48	5.40	5.60	5.14	5.57	5.13
K_2O	5.65	5.93	5.90	5.95	5.63	5.98	5.16
TiO_2	0.83	0.82	0.85	0.69	0.97	0.70	1.30
P_2O_5	0.22	0.22	0.24	0.20	0.25	0.20	0.41
S	0.03	0.02	0.02	<0.01	0.04	0.01	0.05
MnO	0.16	0.17	0.17	0.14	0.15	0.17	0.21
CO_2	0.19	0.13	0.16	0.12	0.58	0.22	0.16
H_2O+	0.34	0.32	0.23	0.27	0.30	0.33	0.28
H_2O-	0.18	0.21	0.29	0.19	0.21	0.17	0.17
Total	99.60	99.30	99.80	99.90	99.90	99.50	100.10

	Unit 6a						
Ref. No.	**999**	**1001**	**1002**	**1003**	**1007**	**1009**	**1010**
SiO_2	60.5	58.18	58.48	56.41	59.16	59.41	58.24
Al_2O_3	16.8	17.66	18.72	18.03	18.10	17.41	18.17
Fe_2O_3	1.11	2.72	1.61	2.23	1.36	2.01	2.10
FeO	5.17	4.67	3.46	4.83	3.70	4.83	4.11
MgO	0.54	0.80	0.69	1.03	0.59	0.52	0.48
CaO	2.25	3.14	3.01	3.33	3.27	3.04	2.46
Na_2O	5.09	5.36	5.31	4.89	5.84	4.64	4.81
K_2O	6.49	5.30	5.33	5.29	4.95	5.98	6.24
TiO_2	0.68	0.87	0.84	1.21	0.62	0.85	0.74
P_2O_5	0.16	0.24	0.21	0.28	0.17	0.22	0.20
S	0.04	0.05	0.04	0.06	0.01	0.04	0.04
MnO	0.19	0.20	0.15	0.20	0.19	0.19	0.18
CO_2	0.35	0.65	0.62	0.63	0.62	0.44	0.52
H_2O+	0.30	0.33	0.29	0.24	0.35	0.08	0.35
H_2O-	0.14	0.20	0.23	0.26	0.22	0.27	0.26
Total	99.80	100.40	99.00	98.90	99.20	99.90	98.90

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
992	C24-27	999	C25-11
993	C24-28	1001	C37-1
994	C24-29	1002	C37-2
995	C24-31	1003	C37-4
996	C24-32	1007	C39-4A
997	C25-3	1009	C49-1
998	C25-7	1010	C49-5

TABLE A-2. CONTINUED.

	Unit 6a				Unit 6b		
Ref. No.	1012	1013	957	962	958	960	961
SiO_2	57.86	59.38	54.57	59.60	59.01	57.81	57.69
Al_2O_3	18.33	18.54	15.45	17.20	19.07	17.88	18.32
Fe_2O_3	2.21	1.85	3.54	2.21	1.52	2.97	2.73
FeO	3.78	2.98	8.21	3.28	2.82	3.78	3.38
MgO	0.82	0.35	1.18	0.74	0.42	0.43	0.47
CaO	3.16	2.32	4.19	1.95	2.59	2.80	2.93
Na_2O	5.05	5.24	4.60	6.36	5.23	5.71	5.75
K_2O	5.54	5.92	4.42	5.65	5.76	5.09	5.03
TiO_2	0.92	0.41	1.35	0.70	0.81	1.02	0.75
P_2O_5	0.28	0.17	0.48	0.17	0.17	0.17	0.16
S	0.04	0.04	0.10	<0.01	0.02	0.01	0.02
MnO	0.15	0.15	0.38	0.16	0.12	0.18	0.19
CO_2	0.43	0.54	0.67	0.45	0.58	0.71	0.60
H_2O+	0.19	0.15	0.31	0.41	0.30	0.04	0.09
H_2O-	0.28	0.27	0.26	0.22	0.18	0.28	0.25
Total	99.00	98.30	99.70	99.10	98.60	98.90	98.40

	Unit 6b			Unit 6c		Unit 6n	Unit 7c
Ref. No.	963	1000	1004	954	955	977	959
SiO_2	61.2	59.02	55.88	66.7	64.1	46.44	59.5
Al_2O_3	17.2	19.11	18.27	14.3	14.3	15.65	17.3
Fe_2O_3	0.98	1.28	1.85	1.58	1.53	3.50	2.55
FeO	3.57	3.22	5.07	2.80	4.76	7.81	4.20
MgO	0.71	0.55	1.32	0.11	0.13	7.68	0.43
CaO	1.77	2.33	3.46	1.09	1.71	12.08	2.26
Na_2O	5.72	5.11	4.67	4.78	5.02	2.26	5.72
K_2O	6.51	6.17	5.32	5.48	5.43	0.96	6.34
TiO_2	0.66	0.71	1.34	0.33	0.51	1.65	0.35
P_2O_5	0.14	0.14	0.36	0.05	0.06	0.40	0.15
S	<0.01	0.02	0.01	<0.01	0.04	0.17	<0.01
MnO	0.09	0.10	0.14	0.11	0.18	0.18	0.22
CO_2	0.10	0.53	0.58	0.96	0.76	0.74	0.08
H_2O+	0.26	0.31	0.0	0.58	0.58	0.40	0.30
H_2O-	0.21	0.24	0.33	0.23	0.25	0.14	0.17
Total	99.10	98.90	98.60	99.10	99.40	100.10	100.00

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1012	C51-3	963	C20-8
1013	C51-4C	1000	C34-1
957	C8-14	1004	C37-5
962	C20-3	954	C6-1
958	C8-16	955	C6-3
960	C19-2	977	C23-12B
961	C19-3	959	C18-1B

TABLE A-2. CONTINUED.

	Unit 5a	Unit 6k			Unit 6e	Unit 6h	
Ref. No.	1005	1006	1011	1014	1008	1035	1026
SiO_2	48.54	60.16	57.0	55.88	61.2	2.18	16.9
Al_2O_3	18.54	18.8	19.17	18.91	15.0	0.70	5.00
Fe_2O_3	1.95	1.46	1.88	1.99	1.22	11.8	14.6
FeO	7.65	3.30	3.06	3.78	7.90	6.15	8.46
MgO	3.89	0.49	0.88	1.56	0.09	0.30	3.80
CaO	9.03	2.65	3.67	3.88	1.72	43.6	24.7
Na_2O	3.49	5.94	4.94	5.20	5.41	0.25	0.22
K_2O	2.26	4.73	5.26	4.85	5.05	0.01	3.57
TiO_2	1.70	0.53	1.05	0.91	0.68	0.01	0.36
P_2O_5	0.65	0.17	0.33	0.26	0.12	1.32	1.50
S	0.19	0.01	0.04	0.03	<0.01	0.16	0.14
MnO	0.17	0.15	0.11	0.13	0.29	0.44	0.45
CO_2	0.87	0.46	0.54	0.62	0.18	31.4	16.8
H_2O+	0.09	0.37	0.07	0.23	0.19	0.04	0.39
H_2O-	0.21	0.21	0.25	0.23	0.18	0.25	0.29
Total	99.20	99.40	98.30	98.50	99.20	98.60	97.20

	Unit 6h			Unit 6j			
Ref. No.	1028	1030	1040	1020	1024	1022	1041
SiO_2	23.7	24.9	2.00	62.6	71.3	48.0	43.0
Al_2O_3	7.00	7.40	1.00	17.1	15.0	15.4	17.1
Fe_2O_3	5.60	4.50	29.4	0.99	0.60	3.50	3.10
FeO	14.2	14.5	13.1	3.85	0.63	7.20	9.45
MgO	4.00	5.40	0.05	0.64	0.11	3.01	2.28
CaO	20.2	18.0	27.6	1.89	0.99	8.00	9.61
Na_2O	0.18	0.31	0.03	5.83	5.53	0.58	4.10
K_2O	4.46	4.99	0.02	5.84	5.70	8.38	5.71
TiO_2	0.47	0.51	0.10	0.63	0.10	0.73	0.34
P_2O_5	1.38	1.66	1.40	0.14	0.05	0.48	0.95
S	0.02	0.06	0.09	0.01	<0.01	0.01	<0.01
MnO	0.48	0.39	1.32	0.10	0.04	0.60	0.29
CO_2	13.2	11.3	19.9	0.17	0.18	1.49	1.50
H_2O+	0.38	1.26	0.08	0.28	0.09	0.14	1.13
H_2O-	0.31	0.39	0.26	0.31	0.28	0.46	0.44
Total	95.60	95.60	96.40	100.40	100.60	98.00	99.00

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1005	C37-6A	1028	CH29 845.8
1006	C39-1	1030	CH29 888.0
1011	C51-2	1040	CH30 652.5
1014	C60-2B	1020	CH29 317.5
1008	C40-5	1024	CH29 602.0
1035	CH30 196.5	1022	CH29 548.0
1026	CH29 679.8	1041	CH102 258.3

TABLE A-2. CONTINUED.

	Unit 6j						
Ref. No.	1025	1015	1016	1029	1017	1018	1019
SiO_2	48.1	48.9	47.2	33.5	61.7	64.9	58.7
Al_2O_3	14.6	15.2	14.1	9.30	17.4	16.5	16.8
Fe_2O_3	2.19	2.19	2.66	9.20	1.52	0.96	2.32
FeO	8.20	8.20	8.95	16.9	3.50	2.38	4.97
MgO	3.85	2.61	3.26	4.40	0.37	0.54	1.03
CaO	8.42	9.00	9.22	15.0	1.98	1.57	3.75
Na_2O	0.92	0.87	0.75	0.71	6.48	5.83	5.81
K_2O	7.60	7.66	7.46	2.32	5.78	5.99	4.37
TiO_2	0.69	0.70	0.67	0.72	0.56	0.47	0.97
P_2O_5	0.63	0.62	0.82	1.36	0.14	0.13	0.30
S	<0.01	<0.01	0.01	0.09	0.01	0.01	<0.01
MnO	0.64	0.60	0.25	0.55	0.19	0.09	0.23
CO_2	0.66	0.52	0.97	1.54	0.22	0.33	0.16
H_2O+	0.84	0.56	1.08	0.31	0.05	0.33	0.12
H_2O-	0.61	0.36	0.44	0.25	0.41	0.42	0.38
Total	98.00	98.00	97.80	96.20	100.30	100.50	99.90

	Unit 6j						
Ref. No.	1021	1023	1027	1031	1032	1033	1034
SiO_2	57.7	62.8	61.7	51.9	60.9	59.9	60.3
Al_2O_3	14.6	17.0	15.1	16.3	17.4	16.3	16.1
Fe_2O_3	3.81	3.44	3.30	3.62	1.48	2.84	2.00
FeO	6.65	1.12	3.78	8.53	3.71	4.90	5.45
MgO	0.57	0.56	0.27	1.04	0.46	0.27	0.50
CaO	3.86	1.33	2.92	4.55	2.06	3.39	2.68
Na_2O	5.35	4.36	6.44	5.73	6.56	5.30	5.79
K_2O	5.08	8.31	5.59	3.30	5.82	6.24	5.48
TiO_2	1.47	0.17	0.47	2.04	0.46	0.64	0.67
P_2O_5	0.20	0.06	0.09	0.77	0.13	0.17	0.18
S	0.03	0.20	0.01	<0.01	<0.01	0.03	0.05
MnO	0.39	0.10	0.35	0.32	0.31	0.30	0.30
CO_2	0.23	0.84	0.20	0.17	0.36	0.18	0.20
H_2O+	0.07	0.27	0.07	0.38	0.11	0.08	0.15
H_2O-	0.33	0.43	0.35	0.84	0.80	0.25	0.27
Total	100.30	101.00	100.60	99.00	100.10	100.80	100.10

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1025	CH29 649.5	1021	CH29 328.4
1015	CH28 698.4	1023	CH29 574.3
1016	CH28 755.9	1027	CH29 803.0
1029	CH29 864.7	1031	CH30 99.9
1017	CH29 67.2	1032	CH30 116.8
1018	CH29 93.0	1033	CH30 149.0
1019	CH29 245.5	1034	CH30 166.5

TABLE A-2. CONTINUED.

	Unit 6j						
Ref. No.	**1036**	**1037**	**1038**	**1039**	**1042**	**1043**	**1044**
SiO_2	62.1	62.3	58.0	62.4	53.0	57.3	53.3
Al_2O_3	15.9	16.4	16.2	16.4	20.5	15.5	21.9
Fe_2O_3	1.72	2.07	2.25	1.96	4.95	2.47	1.28
FeO	3.36	3.01	4.62	3.08	3.22	4.55	3.08
MgO	0.24	0.36	0.98	0.29	0.31	0.59	0.15
CaO	3.58	2.68	3.72	2.35	1.14	5.20	3.14
Na_2O	6.03	6.26	4.56	6.15	6.03	3.48	6.66
K_2O	5.62	5.94	6.98	6.11	8.33	7.76	8.86
TiO_2	0.34	0.41	0.73	0.38	0.19	0.19	0.07
P_2O_5	0.12	0.11	0.30	0.12	0.12	0.22	0.26
S	0.05	0.01	0.01	0.01	0.03	0.04	0.02
MnO	0.26	0.21	0.39	0.22	0.32	0.45	0.15
CO_2	0.26	0.22	0.25	0.19	0.60	1.28	0.83
H_2O+	0.00	0.25	0.14	0.22	0.40	0.24	0.09
H_2O-	0.37	0.38	0.39	0.36	0.37	0.37	0.31
Total	100.00	100.60	99.50	100.20	99.50	99.60	100.10

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1036	CH30 408.1	1042	CH102 470.9
1037	CH30 451.5	1043	CH104 317.0
1038	CH30 549.8	1044	CH104 490.8
1039	CH30 600.3		

TABLE A-3. TRACE ELEMENT ANALYSES (PPM) OF WHOLE-ROCK SAMPLES FROM THE CLAY-HOWELLS ALKALIC ROCK COMPLEX.

	Unit 6a						
Ref. No.	956	964	965	966	967	968	969
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	40	210	640	1000	1210	1140	1290
Be	5	4	<1	<1	<1	<1	<1
Bi							
Co	<5	<5	5	<5	<5	<5	<5
Cr	<5	<5	5	<5	<5	<5	<5
Cu	10	10	10	5	5	<5	5
Ga	25	10	15	15	15	15	10
Hg							
Li	10	15	5	5	3	5	5
Mn							
Mo	15	10	2	<1	2	<1	2
Nb	300	150	60	70	80	70	80
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	80	20	<10	<10	<10	<10	<10
Rb	130	50	40	40	60	60	40
Sb							
Sc	7	30	30	25	35	10	45
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	10	100	200	300	200	200	300
Ti							
V	<5	<5	30	<5	<5	<5	<5
Y	150	50	40	25	25	15	30
Zn	130	160	100	70	90	40	90
Zr	2000	300	100	70	150	35	150
La	900	100	<100	<100	<100	<100	<100
Nd	<300	<300	<300	<300	<300	<300	<300
Ce	1200	<500	<500	<500	<500	<500	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
956	C6-5	967	C20-25
964	C20-8B	968	C20-30
965	C20-12A	969	C20-30B
966	C20-17		

TABLE A-3. CONTINUED.

	Unit 6a						
Ref. No.	**970**	**971**	**972**	**973**	**974**	**975**	**976**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1300	1200	2100	820	810	6200	940
Be	<1	<1	<1	<1	<1	<1	<1
Bi							
Co	<5	6	6	<5	<5	7	6
Cr	<5	<5	<5	<5	<5	<5	5
Cu	5	10	8	5	10	6	8
Ga	10	15	15	15	15	9	15
Hg							
Li	5	8	9	5	5	5	10
Mn							
Mo	2	<1	<1	1	2	<1	<1
Nb	100	80	50	100	150	<30	80
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	20	100	<10	<10	40	90
Rb	40	100	100	60	50	40	90
Sb							
Sc	30	10	8	15	20	10	10
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	400	150	300	400	300	350	150
Ti							
V	<5	<10	<10	<5	<5	<10	<10
Y	25	30	20	30	35	20	45
Zn	80	86	66	70	85	59	112
Zr	200	200	150	250	200	35	250
La	<100	<100	<100	<100	100	<100	<100
Nd	<300	<100	100	<300	<300	<100	<100
Ce	<500	120	<50	<500	<500	<50	160

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
970	C21-2	974	C23-5
971	C22-5	975	C23-8
972	C22-9	976	C23-10
973	C23-2		

TABLE A-3. CONTINUED.

	Unit 6a						
Ref. No.	978	979	980	981	982	983	984
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1200	3000	860	1500	1500	1100	820
Be	<1	<1	<1	<1	<1	<1	<1
Bi							
Co	7	6	6	6	6	6	6
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	8	8	5	8	8	6	8
Ga	15	15	15	15	15	15	10
Hg							
Li	6	4	4	7	6	6	5
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	70	<30	<30	90	70	45	45
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	80	60	80	15	16	13	11
Rb	80	60	80	60	50	70	70
Sb							
Sc	15	10	9	9	9	20	40
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	200	350	150	250	300	150	100
Ti							
V	20	<10	<10	<10	<10	<10	<10
Y	45	20	10	30	25	20	40
Zn	104	72	59	88	88	64	102
Zr	700	80	100	100	150	100	80
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	260	50	70	150	110	100	210

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
978	C23-13	982	C23-28
979	C23-17	983	C23-29
980	C23-20	984	C23-31
981	C23-26		

TABLE A-3. CONTINUED.

	Unit 6a						
Ref. No.	**985**	**986**	**987**	**988**	**989**	**990**	**991**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	740	450	470	370	840	320	280
Be	<1	4	<1	4	3	<1	<1
Bi							
Co	<5	<5	<5	<5	<5	<5	10
Cr	<5	<5	<5	<5	<5	<5	<5
Cu	10	10	10	10	10	5	5
Ga	10	15	10	15	10	10	10
Hg							
Li	5	10	5	5	3	5	5
Mn							
Mo	2	2	2	2	2	<1	1
Nb	150	100	70	100	70	45	60
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	<10	<10	<10	<10	<10	20
Rb	60	70	50	80	60	50	50
Sb							
Sc	25	40	45	25	40	15	30
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	200	100	100	100	100	50	50
Ti							
V	30	<5	<5	<5	<5	<5	<5
Y	70	50	40	45	45	20	20
Zn	110	90	90	80	105	65	65
Zr	250	300	70	250	70	20	200
La	100	100	<100	<100	<100	<100	<100
Nd	<300	<300	<300	<300	<300	<300	<300
Ce	<500	<500	<500	<500	<500	<500	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
985	C24-1B	989	C24-9
986	C24-3	990	C24-17
987	C24-4	991	C24-18
988	C24-5		

TABLE A-3. CONTINUED.

	Unit 6a						
Ref. No.	992	993	994	995	996	997	998
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	820	600	880	760	2700	700	1100
Be	3	<1	<1	<1	<1	<1	<1
Bi							
Co	<5	<5	<5	5	6	<5	5
Cr	<5	<5	<5	<5	6	<5	<5
Cu	10	10	10	<5	8	5	10
Ga	15	10	15	15	10	15	15
Hg							
Li	5	5	5	5	4	5	5
Mn							
Mo	1	1	1	1	<1	2	2
Nb	200	100	100	100	60	100	100
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	10	<10	150	<10	13	<10	<10
Rb	60	50	70	80	50	70	50
Sb							
Sc	15	25	20	15	25	20	30
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	400	200	300	300	300	300	400
Ti							
V	<5	<5	<5	20	<10	<5	80
Y	50	35	35	30	25	35	45
Zn	95	75	80	75	73	75	100
Zr	350	150	150	150	100	200	150
La	<100	<100	<100	<100	<100	<100	100
Nd	<300	<300	<300	<300	<100	<300	<300
Ce	<500	<500	<500	<500	150	<500	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
992	C24-27	996	C24-32
993	C24-28	997	C25-3
994	C24-29	998	C25-7
995	C24-31		

TABLE A-3. CONTINUED.

	Unit 6a						
Ref. No.	**999**	**1001**	**1002**	**1003**	**1007**	**1009**	**1010**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	170	940	1400	2900	2200	840	960
Be	<1	<1	<1	<1	4	<1	<1
Bi							
Co	<5	10	6	6	5	6	5
Cr	<5	6	<5	<5	<5	<5	<5
Cu	5	10	7	8	6	9	7
Ga	10	15	15	10	15	15	15
Hg							
Li	5	6	6	6	20	6	4
Mn							
Mo	1	<1	<1	<1	<1	<1	<1
Nb	100	60	100	70	100	50	35
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	15	15	60	25	12	10
Rb	60	70	50	60	70	70	50
Sb							
Sc	35	30	35	25	40	40	20
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	50	250	300	400	800	150	150
Ti							
V	<5	25	<10	<10	<10	20	<10
Y	30	30	35	25	40	40	15
Zn	70	102	88	88	98	99	64
Zr	200	200	600	200	1500	250	80
La	100	<100	<100	<100	<100	100	<100
Nd	<300	<100	<100	<100	<100	100	<100
Ce	<500	230	120	50	190	280	350

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
999	C25-11	1007	C39-4A
1001	C37-1	1009	C49-1
1002	C37-2	1010	C49-5
1003	C37-4		

TABLE A-3. CONTINUED.

	Unit 6a				Unit 6b		
Ref. No.	1012	1013	957	962	958	960	961
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1800	1200	1800	1020	1500	1500	1700
Be	<1	<1	<1	4	<1	<1	<1
Bi							
Co	8	7	5	5	<5	6	8
Cr	<5	<5	17	<5	8	5	5
Cu	10	9	15	15	10	10	10
Ga	15	15	15	15	15	15	15
Hg							
Li	6	6	10	5	11	15	7
Mn							
Mo	<1	<1	<1	4	<1	3	2
Nb	<30	<30	70	300	70	60	70
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	11	13	24	40	27	26	24
Rb	40	60	70	70	90	60	50
Sb							
Sc	10	10	25	10	15	15	15
Sn	<3	<3	<3	3	<3	<3	<3
Sr	300	200	200	1000	200	350	350
Ti							
V	20	<10	<10	20	<10	<10	<10
Y	<10	30	50	100	30	35	25
Zn	80	74	182	150	78	98	110
Zr	150	700	100	1500	100	150	100
La	<100	<100	<100	250	<100	<100	<100
Nd	<100	<100	<100	<300	<100	<100	<100
Ce	630	130	200	<500	90	160	100

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1012	C51-3	958	C8-16
1013	C51-4C	960	C19-2
957	C8-14	961	C19-3
962	C20-3		

TABLE A-3. CONTINUED.

	Unit 6b			Unit 6c		Unit 6n	Unit 7c
Ref. No.	**963**	**1000**	**1004**	**954**	**955**	**977**	**959**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1240	3100	3800	20	40	660	480
Be	3	<1	<1	8	7	<1	<1
Bi							
Co	5	6	8	<5	<5	6	<5
Cr	5	<5	<5	10	<5	195	<5
Cu	10	5	10	10	15	54	10
Ga	15	15	9	25	20	10	10
Hg							
Li	5	5	9	15	15	6	5
Mn							
Mo	<1	<1	<1	5	15	<1	<1
Nb	250	60	35	450	400	<30	500
Ni	<5	<5	<5	<5	<5	44	<5
Pb	20	14	70	90	80	20	<10
Rb	70	60	70	150	130	20	110
Sb							
Sc	15	25	30	6	10	40	6
Sn	<3	<3	<3	4	3	<3	<3
Sr	400	350	500	10	10	600	700
Ti							
V	25	<10	<10	<5	<5	200	<5
Y	90	25	30	150	200	25	25
Zn	70	70	80	90	125	84	110
Zr	1500	150	75	2000	>0.1%	150	300
La	100	<100	<100	500	1000	<100	100
Nd	<300	<100	<100	<300	<300	<100	<300
Ce	<500	90	130	700	1700	290	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
963	C20-8	955	C6-3
1000	C34-1	977	C23-12B
1004	C37-5	959	C18-1B
954	C6-1		

TABLE A-3. CONTINUED.

	Unit 5a	Unit 6k			Unit 6e	Unit 6h	
Ref. No.	1005	1006	1011	1014	1008	1035	1026
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1000	1800	2700	1800	540	1840	3180
Be	3	3	<1	<1	5	10	15
Bi							
Co	28	6	5	13	<5	<5	10
Cr	18	<5	<5	5	<5	20	170
Cu	24	6	7	10	10	5	15
Ga	15	15	9	15	20	2	9
Hg							
Li	20	25	<3	6	25	<3	15
Mn							
Mo	<1	<1	<1	<1	3	15	3
Nb	80	80	<30	100	300	700	900
Ni	12	<5	<5	<5	<5	<5	40
Pb	80	60	10	14	<10	70	100
Rb	80	60	20	70	100	<10	40
Sb							
Sc	40	45	10	10	20	5	10
Sn	<3	<3	<3	<3	<3	6	9
Sr	700	400	450	450	50	>3500	>3500
Ti							
V	200	<10	10	35	<5	15	30
Y	40	45	10	40	100	450	250
Zn	92	90	39	75	215	300	690
Zr	200	200	40	250	500	250	300
La	<100	100	<100	<100	250	900	900
Nd	<100	<100	<100	<100	<300	>0.1%	450
Ce	340	170	130	200	<500	1500	1500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1005	C37-6A	1008	C40-5
1006	C39-1	1035	CH30 196.5
1011	C51-2	1026	CH29 679.8
1014	C60-2B		

TABLE A-3. CONTINUED.

	Unit 6h			Unit 6j			
Ref. No.	**1028**	**1030**	**1040**	**1020**	**1024**	**1022**	**1041**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	7240	4920	420	900	170	1960	600
Be	20	15	4	3	5	15	5
Bi							
Co	15	15	5	5	<5	10	10
Cr	165	160	5	<5	<5	30	<5
Cu	5	15	15	5	<5	10	10
Ga	8	10	8	15	25	10	9
Hg							
Li	10	10	<3	5	5	30	5
Mn							
Mo	<1	2	8	3	<1	4	4
Nb	900	800	>0.1%	150	<10	450	500
Ni	65	70	<5	<5	<5	15	<5
Pb	80	70	160	20	<10	30	20
Rb	80	60	<10	70	130	100	160
Sb							
Sc	8	15	10	9	<5	7	5
Sn	4	8	50	<3	<3	6	<3
Sr	>3500	>3500	>3500	200	300	3500	2000
Ti							
V	30	45	40	15	<5	50	30
Y	200	200	>0.1%	60	<10	80	60
Zn	840	660	900	75	20	300	340
Zr	250	300	300	700	20	350	45
La	800	700	>0.1%	150	30	500	400
Nd	300	300	>0.1%	<300	<300	<300	<300
Ce	1500	1000	4000	<500	<500	900	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1028	CH29 845.8	1024	CH29 602.0
1030	CH29 888.0	1022	CH29 548.0
1040	CH30 652.5	1041	CH102 258.3
1020	CH29 317.5		

TABLE A-3. CONTINUED.

	Unit 6j						
Ref. No.	1025	1015	1016	1029	1017	1018	1019
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	2160	1960	1880	3420	260	860	1860
Be	15	15	20	30	5	6	4
Bi							
Co	10	15	10	15	<5	<5	5
Cr	40	35	30	300	<5	<5	5
Cu	10	<5	10	15	5	<5	<5
Ga	9	10	10	15	15	15	15
Hg							
Li	10	5	30	5	10	5	10
Mn							
Mo	<1	<1	<1	2	3	25	2
Nb	400	450	600	0.1%	150	90	150
Ni	10	15	15	85	<5	<5	<5
Pb	70	50	50	70	20	20	40
Rb	90	130	110	30	110	130	40
Sb							
Sc	7	7	6	15	10	8	20
Sn	7	6	7	15	4	<3	<3
Sr	>3500	>3500	>3500	>3500	400	400	600
Ti							
V	40	45	35	60	<5	15	25
Y	80	70	100	200	40	70	40
Zn	340	320	360	920	110	65	115
Zr	350	350	400	600	250	350	250
La	600	400	600	900	100	250	100
Nd	<300	<300	<300	300	<300	<300	<300
Ce	800	500	1000	2500	<500	<500	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.
1025	CH29 649.5
1015	CH28 698.4
1016	CH28 755.9
1029	CH29 864.7
1017	CH29 67.2
1018	CH29 93.0
1019	CH29 245.5

TABLE A-3. CONTINUED.

	Unit 6j						
Ref. No.	**1021**	**1023**	**1027**	**1031**	**1032**	**1033**	**1034**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	800	280	1720	2060	780	840	1020
Be	6	7	8	3	10	4	4
Bi							
Co	<5	<5	<5	10	5	<5	<5
Cr	<5	<5	<5	<5	5	<5	<5
Cu	5	15	<5	5	<5	5	10
Ga	15	15	15	15	25	15	15
Hg							
Li	5	5	5	25	10	5	15
Mn							
Mo	9	15	10	40	2	2	5
Nb	300	40	100	90		150	100
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	30	<10	<10	10	30	10	20
Rb	80	110	120	50	220	110	80
Sb							
Sc	20	5	6	30	8	10	20
Sn	<3	<3	<3	3	10	<3	<3
Sr	1000	300	1000	1000	700	1000	300
Ti							
V	<5	<5	<5	10	10	<5	35
Y	50	25	60	50	60	35	35
Zn	260	45	170	270	230	170	150
Zr	200	150	250	150	1000	100	60
La	200	90	200	100	150	100	90
Nd	<300	<300	<300	<300	<300	<300	<300
Ce	<500	<500	<500	<500	<500	<500	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1021	CH29 328.4	1032	CH30 116.8
1023	CH29 574.3	1033	CH30 149.0
1027	CH29 803.0	1034	CH30 166.5
1031	CH30 99.9		

TABLE A-3. CONTINUED.

	Unit 6j						
Ref. No.	1036	1037	1038	1039	1042	1043	1044
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1440	540	1040	660	1580	1980	2020
Be	10	7	15	5	5	6	5
Bi							
Co	<5	<5	5	<5	<5	<5	<5
Cr	<5	<5	<5	<5	5	<5	<5
Cu	10	<5	5	<5	10	5	5
Ga	20	20	20	15	10	15	15
Hg							
Li	5	5	10	5	3	<3	3
Mn							
Mo	9	3	<1	2	2	1	<1
Nb	150	100	200	60	200	500	45
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	20	10	30	20	30	20	<10
Rb	110	130	220	140	150	160	160
Sb							
Sc	7	8	15	8	<5	8	<5
Sn	5	<3	15	<3	3	4	<3
Sr	3500	1500	2500	1000	1500	3500	1000
Ti							
V	<5	<5	20	<5	<5	<5	<5
Y	80	35	70	30	25	20	20
Zn	120	95	280	110	110	150	55
Zr	350	250	400	150	200	250	200
La	400	150	200	100	150	70	35
Nd	<300	<300	<300	<300	<300	<300	<300
Ce	500	<500	500	<500	<500	<500	<500

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1036	CH30 408.1	1042	CH102 470.9
1037	CH30 451.5	1043	CH104 317.0
1038	CH30 549.8	1044	CH104 490.8
1039	CH30 600.3		

TABLE A-4. NORMATIVE MINERALS (CIPW NORM) FOR WHOLE-ROCK SAMPLES FROM THE CLAY-HOWELLS ALKALIC ROCK COMPLEX.

	Unit 6a						
Ref. No.	956	964	965	966	967	968	969
S.G.	2.68	2.77	2.77	2.69	2.71	2.63	2.72
AP	0.118	0.305	0.939	0.492	0.632	0.376	0.851
PO	0.056	0.111	0.139	0.083	0.083	0.028	0.112
IL	0.792	1.443	2.888	1.229	1.839	1.326	2.285
OR	34.473	33.126	32.519	36.596	37.223	41.833	36.542
AB	47.166	44.267	42.578	44.802	41.968	45.949	39.834
AN	0.772	0.811	3.176	5.712	5.635	5.061	4.010
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.345	2.511	3.758	1.862	3.919	1.599	3.547
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.071	0.0	0.0	0.0	0.0	0.0	0.0
FS	2.640	0.0	0.0	0.0	0.0	0.0	0.0
Q	5.731	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.175	1.096	3.206	1.212	1.894	0.709	2.421
FO	0.0	0.492	1.185	0.594	0.810	0.123	0.957
FA	0.0	5.310	2.719	2.534	2.004	0.303	2.676
NE	0.0	1.177	1.668	0.797	0.284	1.310	1.410
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	5.657	9.351	5.823	4.087	3.708	1.384	5.356
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

S.G. - Specific Gravity; AP - Apatite; PO - Pyrrhotite; IL - Ilmenite;
OR - Orthoclase; AB - Albite; AN - Anorthite; C - Corundum; AC - Acmite;
MT - Magnetite; HM - Hematite; WO - Wollastonite; EN - Enstatite;
FS - Ferrosilite; Q - Quartz; DI - Diopside; FO - Forsterite; FA - Fayalite;
NE - Nepheline; LC - Leucite; KP - Kaliophilite; HE - Hedenbergite; CC - Calcite;
RU - Rutile; NS - Na_2SiO_3; KS - Kalsilite; CR - Chromite; LN - Larnite.

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
956	C6-5	967	C20-25
964	C20-8B	968	C20-30
965	C20-12A	969	C20-30B
966	C20-17		

TABLE A-4. CONTINUED.

	Unit 6a						
Ref. No.	970	971	972	973	974	975	976
S.G.	2.72	2.71	2.67	2.69	2.70	2.72	2.71
AP	0.708	0.406	0.404	0.468	0.518	0.856	0.422
PO	0.084	0.085	0.112	0.055	0.056	0.112	0.083
IL	1.933	1.446	0.876	1.208	1.483	2.239	1.575
OR	33.283	35.852	35.464	35.061	34.617	35.589	33.968
AB	44.651	44.055	45.005	47.758	46.169	39.437	43.969
AN	5.865	9.647	11.164	6.738	6.640	14.671	7.784
C	0.0	0.0	0.608	0.0	0.0	0.186	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.072	2.999	2.571	2.855	2.838	2.616	3.504
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.727	0.868	0.300	1.115	0.0	1.165
FS	0.0	2.301	2.388	0.752	3.164	0.0	3.552
Q	0.0	0.0	0.540	0.0	0.212	0.0	1.050
DI	2.302	0.322	0.0	1.128	0.918	0.0	0.800
FO	0.371	0.284	0.0	0.322	0.0	1.735	0.0
FA	0.868	0.989	0.0	0.889	0.0	2.407	0.0
NE	1.602	0.0	0.0	0.0	0.0	0.153	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.261	0.888	0.0	2.465	2.270	0.0	2.128
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
970	C21-2	974	C23-5
971	C22-5	975	C23-8
972	C22-9	976	C23-10
973	C23-2		

TABLE A-4. CONTINUED.

	Unit 6a						
Ref. No.	**978**	**979**	**980**	**981**	**982**	**983**	**984**
S.G.	2.74	2.71	2.65	2.70	2.71	2.69	2.74
AP	0.615	0.587	0.189	0.497	0.513	0.397	0.813
PO	0.140	0.111	0.056	0.084	0.110	0.083	0.110
IL	1.840	1.577	1.005	1.510	1.527	1.263	1.844
OR	32.872	34.131	39.128	32.923	32.104	36.769	34.570
AB	42.275	43.294	45.291	45.545	44.476	45.459	40.389
AN	9.392	10.125	9.060	11.942	13.063	8.489	8.975
C	0.0	0.0	0.044	0.0	0.044	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.534	2.437	2.420	2.424	1.967	2.352	4.005
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0 0	0.0	0.0	0.0	0.0	0.0
EN	1.535	0.0	0.536	0.0	1.226	0.0	1.048
FS	4.092	0.0	1.438	0.0	3.623	0.0	3.656
Q	0.506	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.963	0.975	0.0	0.365	0.0	0.448	0.868
FO	0.0	1.220	0.211	1.073	0.316	0.575	0.224
FA	0.0	2.870	0.624	2.832	1.030	2.186	0.861
NE	0.0	0.860	0.0	0.044	0.0	0.633	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	2.238	1.814	0.0	0.762	0.0	1.347	2.639
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
978	C23-13	982	C23-28
979	C23-17	983	C23-29
980	C23-20	984	C23-31
981	C23-26		

TABLE A-4. CONTINUED.

	Unit 6a						
Ref. No.	985	986	987	988	989	990	991
S.G.	2.75	2.71	2.72	2.70	2.74	2.64	2.69
AP	0.703	0.400	0.443	0.355	0.612	0.562	0.282
PO	0.138	0.083	0.028	0.084	0.111	0.055	0.083
IL	1.995	1.347	1.529	1.183	1.927	1.534	1.556
OR	33.333	35.662	35.946	37.744	36.375	41.089	39.367
AB	42.211	42.095	40.946	40.340	41.384	44.507	43.045
AN	5.866	4.084	5.063	6.817	5.278	5.444	4.684
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.353	2.836	3.735	2.309	3.237	2.723	2.845
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	1.469	0.652	0.887	1.064	1.154	0.603	0.875
FS	3.780	3.736	4.261	4.715	3.984	1.118	2.630
Q	1.065	3.182	0.818	2.950	0.398	0.517	0.253
DI	1.877	0.988	1.222	0.502	1.381	0.706	1.210
FO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.210	4.935	5.122	1.938	4.159	1.141	3.171
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
985	C24-1B	989	C24-9
986	C24-3	990	C24-17
987	C24-4	991	C24-18
988	C24-5		

TABLE A-4. CONTINUED.

	Unit 6a						
Ref. No.	**992**	**993**	**994**	**995**	**996**	**997**	**998**
S.G.	2.71	2.70	2.70	2.69	2.72	2.69	2.76
AP	0.516	0.517	0.562	0.467	0.587	0.470	0.957
PO	0.083	0.056	0.055	0.028	0.111	0.028	0.138
IL	1.594	1.579	1.629	1.319	1.865	1.346	2.483
OR	33.786	35.559	35.222	35.419	33.705	35.817	30.697
AB	47.044	47.003	46.111	47.682	42.700	46.951	43.653
AN	6.708	4.872	5.302	5.608	11.532	4.032	6.233
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.906	2.469	3.746	3.093	2.333	3.171	3.602
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.244	0.54	0.825	0.094	0.0	0.0	0.447
FS	0.698	0.169	1.508	0.176	0.0	0.0	0.795
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	1.367	1.443	1.930	1.843	0.479	1.818	3.150
FO	0.638	0.520	0.010	0.407	1.505	0.346	0.998
FA	2.009	1.801	0.021	0.843	3.570	1.086	1.957
NE	0.0	0.0	0.0	0.0	0.713	0.416	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.409	3.958	3.078	3.021	0.900	4.519	4.889
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
992	C24-27	996	C24-32
993	C24-28	997	C25-3
994	C24-29	998	C25-7
995	C24-31		

TABLE A-4. CONTINUED.

	Unit 6a						
Ref. No.	999	1001	1002	1003	1007	1009	1010
S.G.	2.70	2.75	2.70	2.74	2.70	2.73	2.70
AP	0.375	0.561	0.498	0.664	0.403	0.515	0.475
PO	0.111	0.138	0.112	0.168	0.028	0.111	0.112
IL	1.305	1.666	1.631	2.351	1.202	1.629	1.438
OR	38.775	31.613	32.226	32.007	29.890	35.685	37.759
AB	43.499	44.629	45.922	41.757	47.860	39.606	41.632
AN	3.848	8.534	11.745	11.877	8.722	9.081	9.763
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.626	3.977	2.386	3.307	2.013	2.940	3.115
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.126	0.0	0.222	0.0	0.0	0.933	0.301
FS	0.716	0.0	0.485	0.0	0.0	4.318	1.197
Q	0.0	0.0	0.0	0.0	0.0	1.126	0.0
DI	0.931	1.484	0.618	0.969	1.462	0.806	0.267
FO	0.561	0.926	0.874	1.524	0.576	0.0	0.560
FA	3.514	2.590	2.103	3.375	2.143	0.0	2.456
NE	0.0	0.597	0.0	0.305	1.398	0.0	0.0
EC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.614	3.286	1.177	1.697	4.303	3.252	0.927
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
999	C25-11	1007	C39-4A
1001	C37-1	1009	C49-1
1002	C37-2	1010	C49-5
1003	C37-4		

TABLE A-4. CONTINUED.

	Unit 6a				Unit 6b		
Ref. No.	**1012**	**1013**	**957**	**962**	**958**	**960**	**961**
S.G.	2.71	2.68	2.84	2.68	2.68	2.72	2.72
AP	0.662	0.405	1.131	0.402	0.404	0.403	0.381
PO	0.112	0.113	0.279	0.028	0.056	0.028	0.056
IL	1.781	0.800	2.605	1.356	1.577	1.980	1.462
OR	33.396	35.977	26.563	34.092	34.933	30.770	30.543
AB	43.545	45.550	39.542	47.557	45.370	47.270	46.739
AN	11.183	9.832	8.580	1.718	11.825	8.291	9.559
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.266	2.756	5.215	3.269	2.260	4.401	4.063
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.195	0.685	0.975	0.0	0.622	0.0	0.0
FS	0.354	2.659	3.389	0.0	1.620	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.956	0.168	1.996	2.312	0.054	1.160	1.135
FO	1.011	0.093	0.761	0.566	0.298	0.390	0.473
FA	2.025	0.397	2.916	1.117	0.857	1.244	1.329
NE	0.0	0.0	0.0	3.975	0.0	1.140	1.735
EC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	1.515	0.567	6.050	3.608	0.123	2.924	2.524
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1012	C51-3	958	C8-16
1013	C51-4C	960	C19-2
957	C8-14	961	C19-3
962	C20-3		

TABLE A-4. CONTINUED.

	Unit 6b			Unit 6c		Unit 6n	Unit 7c
Ref. No.	963	1000	1004	954	955	977	959
S.G.	2.67	2.68	2.75	2.66	2.70	3.05	2.71
AP	0.330	0.332	0.855	0.119	0.142	0.940	0.351
PO	0.028	0.056	0.028	0.028	0.112	0.472	0.028
IL	1.272	1.380	2.605	0.644	0.991	3.175	0.671
OR	39.071	37.335	32.213	33.301	32.857	5.753	37.869
AB	46.017	43.761	40.033	41.549	43.449	19.374	41.766
AN	2.044	10.888	13.477	1.402	0.446	30.115	2.817
C	0.0	0.122	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	1.442	1.899	2.746	2.354	2.269	5.142	3.734
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.151	0.165	0.543	0.0
FS	0.0	0.0	0.0	1.910	3.466	0.237	0.0
Q	0.0	0.0	0.0	15.178	9.170	0.0	0.0
DI	1.511	0.0	0.560	0.280	0.359	16.328	1.210
FO	0.766	0.982	2.176	0.0	0.0	7.895	0.365
FA	2.284	2.992	4.223	0.0	0.0	3.803	2.025
NE	1.672	0.254	0.224	0.0	0.0	0.0	3.849
EC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.563	0.0	0.860	3.083	6.574	6.224	5.315
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
963	C20-8	955	C6-3
1000	C34-1	977	C23-12B
1004	C37-5	959	C18-1B
954	C6-1		

TABLE A-4. CONTINUED.

	Unit 5a	Unit 6k			Unit 6e	Unit 6h	
Ref. No.	**1005**	**1006**	**1011**	**1014**	**1008**	**1035**	**1026**
S.G.	2.92	2.70	2.70	2.74	2.76	3.01	3.11
AP	1.539	0.401	0.786	0.619	0.282	4.581	4.369
PO	0.532	0.028	0.113	0.084	0.028	0.656	0.482
IL	3.296	1.023	2.048	1.775	1.309	0.028	0.859
OR	13.645	28.437	31.953	29.464	30.268	0.0	0.0
AB	26.604	51.081	42.925	40.283	46.381	0.0	0.0
AN	28.831	10.830	14.980	14.299	1.742	1.135	2.638
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.886	2.152	2.799	2.963	1.792	25.594	26.582
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	125.725	40.780
EN	0.0	1.043	0.273	0.0	0.178	0.0	0.0
FS	0.0	3.605	0.296	0.0	10.213	0.0	0.0
Q	0.0	0.0	0.0	0.0	2.375	-64.824	-16.180
DI	5.682	0.301	0.640	1.641	0.106	0.0	0.0
FO	5.083	0.040	1.178	2.263	0.0	0.783	8.327
FA	5.299	0.153	1.405	2.512	0.0	1.950	3.045
NE	1.916	0.0	0.0	2.656	0.0	1.714	1.266
EC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.050	15.066
HE	4.687	0.906	0.604	1.441	5.327	0.0	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	2.607	12.766

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1005	C37-6A	1008	C40-5
1006	C39-1	1035	CH30 196.5
1011	C51-2	1026	CH29 679.8
1014	C60-2B		

TABLE A-4. CONTINUED.

	Unit 6h			Unit 6j			
Ref. No.	1028	1030	1040	1020	1024	1022	1041
S.G.	3.13	3.03	3.48	2.67	2.60	2.89	2.93
AP	3.919	4.662	4.269	0.326	0.116	1.161	2.297
PO	0.067	0.199	0.324	0.028	0.0	0.029	0.0
IL	1.093	1.173	0.250	1.201	0.190	1.446	0.673
OR	0.0	0.0	0.0	34.677	33.699	36.144	3.593
AB	0.0	0.0	0.0	49.516	45.367	0.0	0.0
AN	6.251	4.900	3.332	3.241	0.0	15.269	11.859
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	1.231	0.0	0.0
MT	9.940	7.899	56.028	1.441	0.253	5.292	4.685
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	6.732	0.0	66.585	0.0	0.785	0.0	0.0
EN	0.0	0.0	0.0	1.067	0.0	0.0	0.0
FS	0.0	0.0	0.0	3.587	0.0	0.0	0.0
Q	-3.845	-1.227	-34.470	0.400	16.036	0.0	0.0
DI	0.0	0.0	0.0	1.149	0.59	8.736	8.192
FO	8.546	11.410	0.115	0.0	0.0	2.640	1.486
FA	20.311	21.080	1.712	0.0	0.0	3.958	4.261
NE	1.010	1.720	0.181	0.0	0.0	2.772	19.588
EC	0.0	0.0	0.0	0.0	0.0	12.189	24.787
KP	18.349	20.304	0.088	0.0	0.0	0.0	0.0
HE	0.0	0.0	0.0	3.367	1.733	10.364	18.580
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	27.627	27.879	1.587	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1028	CH29 845.8	1024	CH29 602.0
1030	CH29 888.0	1022	CH29 548.0
1040	CH30 652.5	1041	CH102 258.3
1020	CH29 317.5		

TABLE A-4. CONTINUED.

	Unit 6j						
Ref. No.	**1025**	**1015**	**1016**	**1029**	**1017**	**1018**	**1019**
S.G.	2.92	2.94	2.95	3.48	2.67	2.62	2.75
AP	1.525	1.489	1.995	3.356	0.326	0.303	0.701
PO	0.0	0.0	0.029	0.262	0.028	0.028	0.0
IL	1.367	1.377	1.335	1.455	1.068	0.898	1.856
OR	35.657	38.048	32.474	0.0	34.317	35.657	26.043
AB	0.0	0.0	0.0	0.0	49.611	49.641	49.291
AN	13.813	15.456	13.689	16.307	1.312	1.155	6.897
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	3.313	3.288	4.045	14.188	2.212	1.401	3.389
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.562	0.0
FS	0.0	0.0	0.0	0.0	0.0	1.223	0.0
Q	0.0	0.0	0.0	0.0	0.0	4.184	0.0
DI	9.644	8.126	9.823	8.382	1.246	1.707	2.753
FO	3.877	2.077	2.775	5.444	0.243	0.0	0.917
FA	5.926	4.652	5.106	12.538	1.327	0.0	2.377
NE	4.399	4.130	3.605	3.461	2.936	0.0	0.128
EC	8.815	6.959	10.824	11.445	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	11.664	14.398	14.301	15.272	5.376	3.241	5.648
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	7.890	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1025	CH29 649.5	1017	CH29 67.2
1015	CH28 698.4	1018	CH29 93.0
1016	CH28 755.9	1019	CH29 245.5
1029	CH29 864.7		

TABLE A-4. CONTINUED.

	Unit 6J						
Ref. No.	1021	1023	1027	1031	1032	1033	1034
S.G.	2.80	2.62	2.73	2.87	2.68	2.74	2.73
AP	0.465	0.140	0.209	1.821	0.304	0.393	0.420
PO	0.083	0.552	0.027	0.0	0.0	0.082	0.138
IL	2.800	0.325	0.892	3.949	0.880	1.212	1.279
OR	30.138	49.475	33.058	19.897	34.670	36.810	32.584
AB	43.606	37.130	43.390	41.072	46.554	40.939	47.952
AN	0.810	2.265	0.0	9.178	0.836	2.235	1.753
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	7.019	0.0	0.0	0.0	0.0
MT	5.541	2.012	1.266	5.350	2.161	4.107	2.915
HM	0.0	2.075	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.038	0.0	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	2.961	0.0	0.0	0.0	0.0	0.0
DI	2.725	3.028	1.378	1.731	1.458	1.336	1.438
FO	0.112	0.0	0.024	1.288	0.335	0.036	0.410
FA	0.632	0.0	0.234	5.424	1.742	0.355	2.759
NE	0.972	0.0	1.689	4.520	5.061	2.049	0.70
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	12.115	0.0	10.814	5.770	6.0	10.445	7.653
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1021	CH29 328.4	1032	CH30 116.8
1023	CH29 574.3	1033	CH30 149.0
1027	CH29 803.0	1034	CH30 166.5
1031	CH30 99.9		

TABLE A-4. CONTINUED.

	Unit 6J						
Ref. No.	**1036**	**1037**	**1038**	**1039**	**1042**	**1043**	**1044**
S.G.	2.72	2.68	2.76	2.68	2.69	2.75	2.66
AP	0.280	0.256	0.705	0.280	0.284	0.522	0.610
PO	0.138	0.027	0.028	0.028	0.084	0.112	0.055
IL	0.650	0.781	1.404	0.726	0.368	0.369	0.134
OR	33.477	35.220	41.813	36.334	50.212	46.963	53.010
AB	49.727	48.068	32.304	48.204	14.843	24.192	0.822
AN	0.0	0.0	3.141	0.0	4.327	3.819	3.714
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.490	1.510	0.0	1.530	0.0	0.0	0.0
MT	2.266	2.252	3.304	2.090	7.314	3.664	1.877
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	2.359	0.764	0.0	0.0	0.0	1.060	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	1.298	1.938	3.636	1.565	0.168	3.243	0.763
FO	0.0	0.0	0.551	0.0	0.497	0.0	0.017
FA	0.0	0.0	1.518	0.003	1.405	0.0	0.234
NE	0.593	1.793	3.667	1.285	20.124	3.214	30.431
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	8.721	7.390	7.929	7.957	0.375	12.841	8.332
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Ref. No.	Sample No.	Ref. No.	Sample No.
1036	CH30 408.1	1042	CH102 470.9
1037	CH30 451.5	1043	CH104 317.0
1038	CH30 549.8	1044	CH104 490.8
1039	CH30 600.3		

TABLE A-5. AVERAGE CHEMICAL COMPOSITIONS* (WEIGHT PERCENT AND PPM) OF LITHOLOGIC UNITS FOR THE CLAY-HOWELLS ALKALIC ROCK COMPLEX.

	Unit 6a (N = 49)		Unit 6b (N = 7)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	59.34	1.56	58.89	2.02
Al_2O_3	17.50	1.09	18.15	0.78
Fe_2O_3	2.00	0.50	1.77	0.79
FeO	4.15	1.17	3.62	0.71
MgO	0.66	0.25	0.65	0.32
CaO	2.69	0.51	2.52	0.62
Na_2O	5.19	0.35	5.42	0.43
K_2O	5.83	0.47	5.77	0.64
TiO_2	0.82	0.21	0.85	0.25
P_2O_5	0.23	0.08	0.18	0.08
MnO	0.18	0.06	0.13	0.04
CO_2	0.38	0.23	0.46	0.25
S	0.03	0.02	0.01	0.01
H_2O+	0.26	0.11	0.20	0.15
H_2O-	0.23	0.04	0.24	0.05
LOI	0.16	0.22	0.09	0.15
TOTAL	99.49	0.56	98.89	0.43
S.G.	0.00	0.00	0.00	0.00
Ag	<1.00	0.00	<1.00	0.00
Ba	1214.08	1020.64	1991.43	1034.98
Co	1.18	5.72	4.71	4.46
Cr	<3.69	4.19	2.57	5.29
Cu	7.76	3.57	9.29	1.89
Li	6.20	2.99	8.14	3.80
Ni	<5.00	0.00	<5.00	0.00
Pb	20.53	40.48	28.71	18.73
Zn	88.37	25.67	81.57	16.51
Be	<0.10	1.93	0.14	1.95
Mo	0.78	2.87	0.00	1.73
Sc	22.69	11.43	18.57	6.27
V	<0.51	16.56	0.00	17.08
Ga	13.76	2.83	14.14	2.27
Nb	81.63	67.46	106.43	83.10
Rb	63.06	17.58	65.71	12.72
Sr	250.20	173.51	364.29	89.97
Y	36.02	23.36	46.43	29.96
Zr	280.61	390.10	653.57	964.41
Sn	<2.51	2.69	<3.00	0.00
Eu	<100.00	0.00	<100.00	0.00
Yb	0.68	1.43	0.40	1.34
Ce	<168.78	396.36	<61.43	300.63
La	<39.80	162.33	<42.86	97.59
Nd	<206.12	108.80	<157.14	97.59

*The average compositions may include duplicate samples or analyses which are not listed in Tables A-2 to A-4.

TABLE A-5 . CONTINUED.

	Unit 6c (N = 2)		Unit 6h (N = 6)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	65.40	1.84	12.01	11.11
Al_2O_3	14.30	0.00	3.63	3.21
Fe_2O_3	1.56	0.04	12.95	8.96
FeO	3.78	1.39	10.43	3.96
MgO	0.12	0.01	2.26	2.41
CaO	1.40	0.44	29.62	11.34
Na_2O	4.90	0.17	0.21	0.10
K_2O	5.45	0.04	2.18	2.41
TiO_2	0.42	0.13	0.24	0.23
P_2O_5	0.05	0.01	1.43	0.13
MnO	0.15	0.05	0.59	0.36
CO_2	0.86	0.14	20.67	8.83
S	0.01	0.04	0.10	0.06
H_2O+	0.58	0.00	0.37	0.46
H_2O-	0.24	0.01	0.28	0.07
LOI	0.00	0.00	0.00	0.00
TOTAL	99.25	0.21	96.98	1.35
S.G.	0.00	0.00	0.00	0.00
Ag	<1.00	0.00	<1.00	0.00
Ba	30.00	14.14	3236.67	2480.11
Co	<5.00	0.00	5.83	9.17
Cr	2.50	10.61	90.00	82.40
Cu	12.50	3.54	10.00	5.48
Li	15.00	0.00	4.33	8.24
Ni	<5.00	0.00	26.67	36.15
Pb	85.00	7.07	91.67	35.45
Zn	107.50	24.75	615.00	259.98
Be	7.50	0.71	12.00	5.76
Mo	10.00	7.07	7.00	6.84
Sc	8.00	2.83	9.00	3.58
V	<5.00	0.00	29.17	12.42
Ga	22.50	3.54	6.50	3.56
Nb	425.00	35.36	633.35	344.44
Rb	140.00	14.14	25.00	40.37
Sr	10.00	0.00	>3500.0	*
Y	175.00	35.36	250.02	161.21
Zr	1000.05	1414.14	275.00	27.39
Sn	3.50	0.71	13.67	17.90
Eu				
Yb				
Ce	1200.00	707.11	1833.33	1080.12
La	750.00	353.55	700.02	352.10
Nd	<300.00	0.00	175.05	199.32

* All strontium assays greater than 3500 ppm.

TABLE A-5 . CONTINUED.

	Unit 6J* (N = 17)	
	Mean	Std. Deviation
SiO_2	59.35	3.75
Al_2O_3	16.84	1.81
Fe_2O_3	2.47	1.06
FeO	4.11	1.71
MgO	0.50	0.28
CaO	2.94	1.13
Na_2O	5.70	0.86
K_2O	6.21	1.45
TiO_2	0.60	0.50
P_2O_5	0.20	0.16
MnO	0.27	0.10
CO_2	0.38	0.32
S	0.03	0.05
H_2O+	0.17	0.12
H_2O-	0.35	0.05
LOI	0.00	0.00
TOTAL	100.12	0.52
S.G.	0.00	0.00
Ag	<1.00	0.00
Ba	1161.18	612.35
Co	<2.35	5.04
Cr	<3.24	3.93
Cu	2.94	6.63
Li	7.24	6.06
Ni	<5.00	0.00
Pb	16.47	14.98
Zn	147.35	74.04
Be	6.47	2.96
Mo	7.53	10.65
Sc	10.18	8.82
V	3.53	13.08
Ga	16.18	3.32
Nb	151.56	114.28
Rb	124.71	49.51
Sr	1247.06	1005.06
Y	43.82	18.67
Zr	268.24	208.48
Sn	0.82	5.47
Eu		
Yb		
Ce	<382.35	332.11
La	146.18	86.27
Nd	<300.00	0.00

* Includes only syenitic samples.

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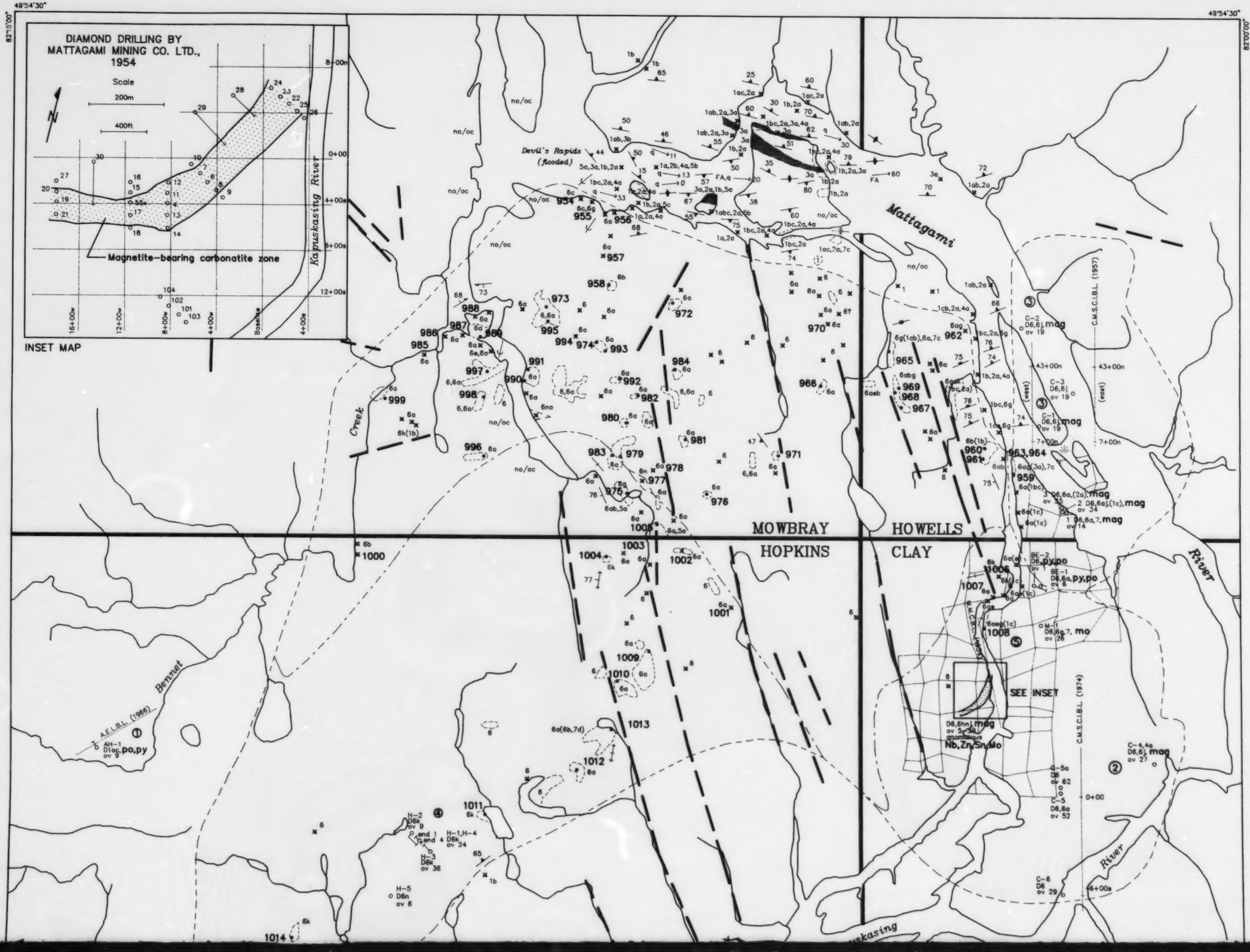
Chart A — Clay–Howells Alk

Figure 3. Geology of the Clay–Howells
Geology by R.P. Sage. Additional inform
work files and private files of Pickar
Cleveland, Ohio.



LEGEND

CENOZOIC[1]

QUATERNARY

RECENT

Stream, lake, and swamp

PLEISTOCENE

Glacial deposits

UNCONFORMITY

LATE PRECAMBRIAN (PROTEROZ

CLAY-HOWELLS ALKALIC ROC

Dike Rocks[3]

7 — 7c Amphibole syenite, general
7d Melanocratic amphibole–py

INTRUSIVE CONTAC

Carbonatite[4]

6h — 6h Silicocarbonatite (biotite–m
aegirine augite–apatite roc
rich rock.

INTRUSIVE & GRADATIONAL

Syenite Contact Rocks[4]

6j — 6j Mafic biotite–amphibole–p
index > 20), fine grained,
aegirine augite syenite; fin
mafic veins; alkalic granite

GRADATIONAL CONT

Syenitic Rocks

6 — 6 Unsubdivided.
6a Green, olivine–bearing, bio
syenite, medium to coarse
6b Brown olivine–bearing, bio
blende)–pyroxene syenite.
6c Biotite–clinopyroxene–amp
6e Fine–grained olivine–bearin
pyroxene syenite.
6g Inhomogeneous syenite, ap
phase of syenite; locally po
stricted to outer contact zo
6k Red–brown, amphibole–pyr
some samples granoblastic
6n Biotite gabbro (± olivine),

INTRUSIVE CONTAC

MIDDLE PRECAMBRIAN (PROTER

MAFIC INTRUSIVE ROCKS

5 — 5 Unsubdivided.
5a Diabase, fine grained, equ
5b Pyroxene–porphyritic diaba
5c Feldspar–porphyritic diaba

INTRUSIVE CONTAC

EARLY PRECAMBRIAN (ARCHEAN

LATE FELSIC INTRUSIVE ROCK

4 — 4a Granite to quartz monzonit

Chart A — Clay–Howells Alkalic Rock Complex

Figure 3. Geology of the Clay–Howells Alkalic Rock Complex. Geology by R.P. Sage. Additional information from assessment work files and private files of Pickands Mather Company, Cleveland, Ohio.

LEGEND

CENOZOIC[1]

QUATERNARY

RECENT

Stream, lake, and swamp deposits

PLEISTOCENE

Glacial deposits

UNCONFORMITY

LATE PRECAMBRIAN (PROTEROZOIC)[2]

CLAY-HOWELLS ALKALIC ROCK COMPLEX

Dike Rocks[3]

7 — 7c Amphibole syenite, generally with trachytoid texture.
7d Melanocratic amphibole–pyroxene–oligoclase syenite.

INTRUSIVE CONTACT

Carbonatite[4]

6h — 6h Silicocarbonatite (biotite–magnetite–carbonate–aegirine augite–apatite rock); carbonatite; magnetite–rich rock.

INTRUSIVE & GRADATIONAL CONTACTS

Syenite Contact Rocks[4]

6j — 6j Mafic biotite–amphibole–pyroxene syenite (colour index > 20), fine grained, granoblastic; granoblastic aegirine augite syenite; fine–grained syenite with dark mafic veins; alkalic granite, probably dikes.

GRADATIONAL CONTACT

Syenitic Rocks

6 — 6 Unsubdivided.
6a Green, olivine–bearing, biotite–amphibole, pyroxene syenite, medium to coarse grained, equigranular.
6b Brown olivine–bearing, biotite–amphibole (hornblende)–pyroxene syenite.
6c Biotite–clinopyroxene–amphibole granite.
6e Fine–grained olivine–bearing, biotite–amphibole–pyroxene syenite.
6g Inhomogeneous syenite, aplitic fracture fillings, late phase of syenite; locally porphyritic, xenolithic; restricted to outer contact zone of syenite intrusion.
6k Red–brown, amphibole–pyroxene–biotite syenite, some samples granoblastic.
6n Biotite gabbro (± olivine), medium grained.

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN (PROTEROZOIC)[2]

MAFIC INTRUSIVE ROCKS

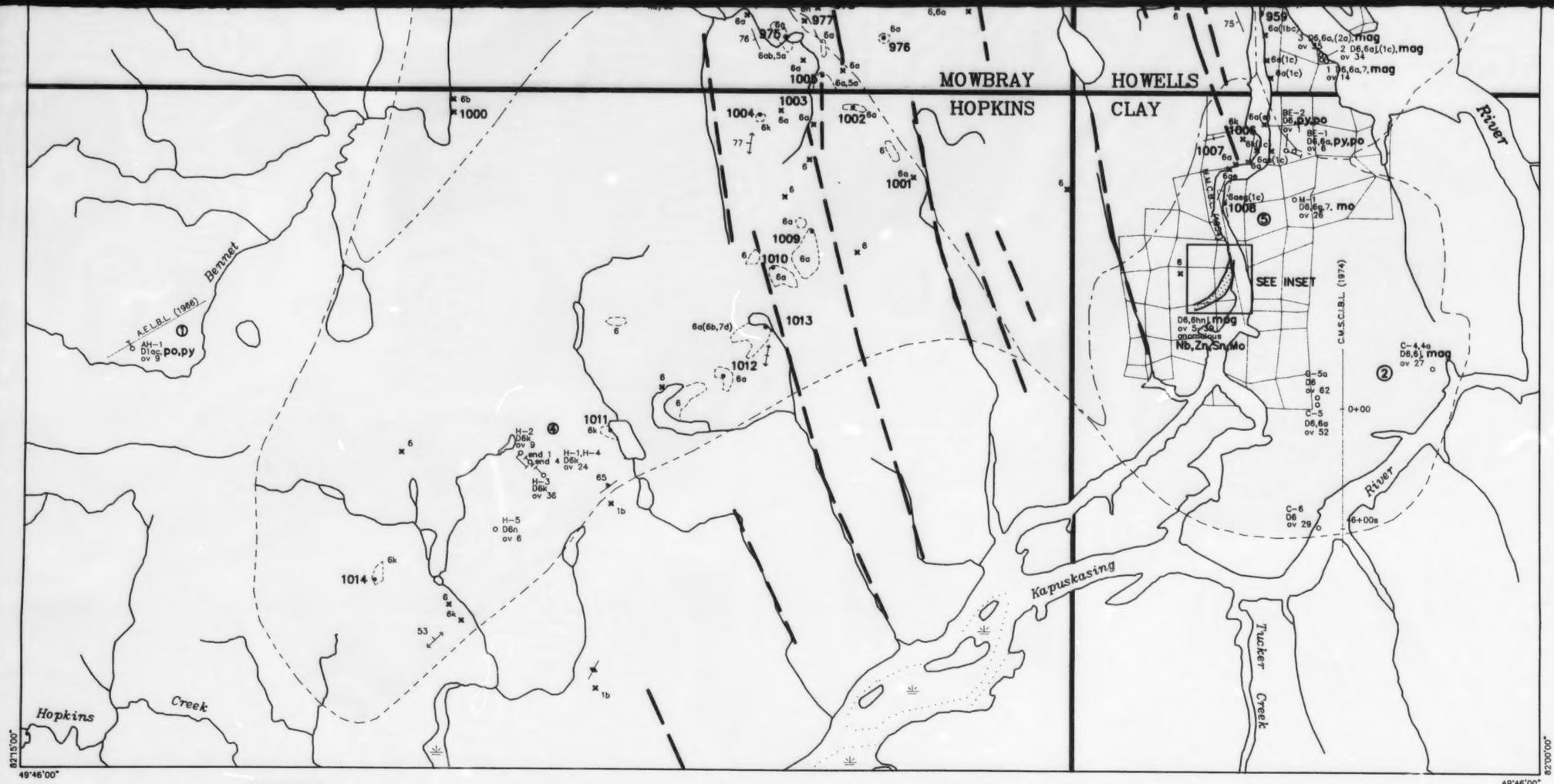
5 — 5 Unsubdivided.
5a Diabase, fine grained, equigranular.
5b Pyroxene–porphyritic diabase.
5c Feldspar–porphyritic diabase.

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)[2]

LATE FELSIC INTRUSIVE ROCKS[3]

4 — 4a Granite to quartz monzonite dikes; granitic pegmatite.



SYMBOLS

- Small bedrock outcrop.
- Area of bedrock outcrop.
- Lithology from diamond drilling.
- Location of sample for whole rock analysis (see report appendix).
- Magnetite-bearing carbonatite.
- Schistosity; (inclined, vertical).
- Mafic segregation banding; (inclined).
- Trachytoid texture defined by feldspars; (inclined, vertical).
- Gneissosity; (inclined, vertical).
- Gneissic banding in xenoliths; (inclined, vertical).
- Lineation with plunge; (FA – fold axis, q – quartz rodding).
- Lineament
- Geological boundary (position interpreted, position deduced from geophysics).
- Diamond drill hole; (vertical, inclined, ov – overburden depth in metres). Prefix indicates company: AH – Argor Explor.; BE – Bewabik Minerals; C – Chibougamau Mining & Smelting; H – Hopkins Tp. Syndicate; M and unprefixed – Mattagami Mining.
- Baseline for exploration program: AELBL – Argor Explor. Ltd.; MMCBL – Matagami Mining Co. Ltd.; CMSCI – Chibougamau Mining & Smelting Co. Inc.
- Glacial striae.
- Township line.
- Swamp.

Scale 1:50 000

Metres 1000 0 1 2 Kilometres

Miles 0 1 Mile

PROPERTIES, EXPLORATION AREAS

1. Argor Explorations Ltd. [1966]
2. Chibougamau Mining and Smelting Co. Inc. (Bradley option) [1957]
3. Chibougamau Mining and Smelting Co. Inc. (Spencer option) [1957]
4. Hopkins Township Syndicate
5. Mattagami Mining Co. Ltd. (Bewabik Minerals Ltd.)

6j Mafic biotite–amphibole–pyroxene syenit index > 20), fine grained, granoblastic; aegirine augite syenite; fine–grained syen mafic veins; alkalic granite, probably di

GRADATIONAL CONTACT

Syenitic Rocks

6 Unsubdivided.
6a Green, olivine–bearing, biotite–amphibo syenite, medium to coarse grained, equi
6b Brown olivine–bearing, biotite–amphibol blende)–pyroxene syenite.
6c Biotite–clinopyroxene–amphibole granite
6e Fine–grained olivine–bearing, biotite–am pyroxene syenite.
6g Inhomogeneous syenite, aplitic fracture phase of syenite; locally porphyritic, xen stricted to outer contact zone of syenite
6k Red–brown, amphibole–pyroxene–biotite some samples granoblastic.
6n Biotite gabbro (± olivine), medium grai

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN (PROTEROZOIC)[2]

MAFIC INTRUSIVE ROCKS

5 Unsubdivided.
5a Diabase, fine grained, equigranular.
5b Pyroxene–porphyritic diabase.
5c Feldspar–porphyritic diabase.

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)[2]

LATE FELSIC INTRUSIVE ROCKS[3]

4a Granite to quartz monzonite dikes; grani

INTRUSIVE CONTACT

MAFIC INTRUSIVE ROCKS[3]

3a Metagabbro (garnet–clinopyroxene–amp clase gneiss).
3b Porphyritic metagabbro dike.

INTRUSIVE CONTACT (?)

FELSIC INTRUSIVE ROCKS[3]

2a Trondhjemite to granodiorite (?) dikes, pegmatitic, granoblastic; intrudes gneissi par–lit.

INTRUSIVE CONTACT

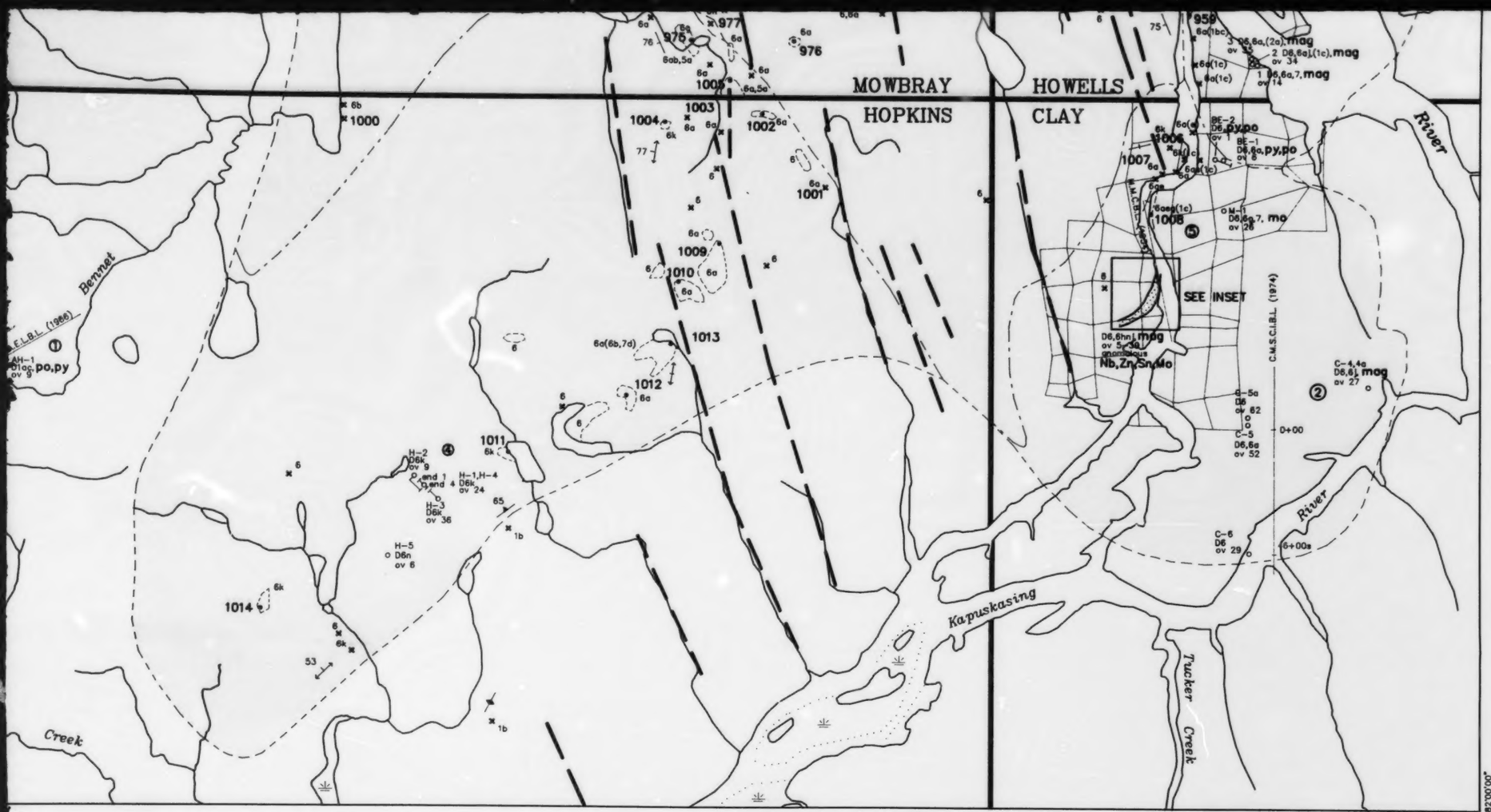
GNEISSIC ROCKS

1a Garnet–biotite–clinopyroxene–amphibole spar paragneiss, fine to medium grained tic.
1b Biotite–clinopyroxene–quartz–feldspar or fine to medium grained, granoblastic.
1c Amphibolite (clinopyroxene–amphibole– clase)granoblastic; may represent sill–lik or mafic volcanic rocks.

NOTES

1. Unconsolidated deposits.
2. Bedrock geology.
3. Age relationships difficult to establish.
4. These rocks do not outcrop; they were intersected in holes of Pickands Mather Co. Descriptions are petrographic examination of drill core by the author an Pickands Mather Co.

Rock types in brackets are xenolithic in the preceding rock ty



SYMBOLS

- bedrock outcrop.
- f bedrock outcrop.
- gy from diamond drilling.
- n of sample for whole rock analysis (see report appendix).
- tite–bearing carbonatite.
- sity; (inclined, vertical).
- egregation banding; (inclined).
- oid texture defined by feldspars; (inclined, vertical).
- sity; (inclined, vertical).
- banding in xenoliths; (inclined, vertical).

- Lineation with plunge; (FA – fold axis, q – quartz rodding).
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- Geological boundary (position interpreted, position deduced from geophysics).
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- Glacial striae.
- Township line.
- Swamp.

Scale 1:50 000

Metres 1000 0 1 2 Kilometres

Miles 0 1 Mile

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4. Hopkins Township Syndicate
5. Mattagami Mining Co. Ltd. (Bewabik Minerals Ltd.)

6j Mafic biotite–amphibole–pyroxene syenite (colour index > 20), fine grained, granoblastic; granoblastic aegirine augite syenite; fine–grained syenite with dark mafic veins; alkalic granite, probably dikes.

GRADATIONAL CONTACT

Syenitic Rocks

6 Unsubdivided.
6a Green, olivine–bearing, biotite–amphibole, pyroxene syenite, medium to coarse grained, equigranular.
6b Brown olivine–bearing, biotite–amphibole (hornblende)–pyroxene syenite.
6c Biotite–clinopyroxene–amphibole granite.
6e Fine–grained olivine–bearing, biotite–amphibole–pyroxene syenite.
6g Inhomogeneous syenite, aplitic fracture fillings, late phase of syenite; locally porphyritic, xenolithic; restricted to outer contact zone of syenite intrusion.
6k Red–brown, amphibole–pyroxene–biotite syenite, some samples granoblastic.
6n Biotite gabbro (± olivine), medium grained.

INTRUSIVE CONTACT

MIDDLE PRECAMBRIAN (PROTEROZOIC)[2]

MAFIC INTRUSIVE ROCKS

5 Unsubdivided.
5a Diabase, fine grained, equigranular.
5b Pyroxene–porphyritic diabase.
5c Feldspar–porphyritic diabase.

INTRUSIVE CONTACT

EARLY PRECAMBRIAN (ARCHEAN)[2]

LATE FELSIC INTRUSIVE ROCKS[3]

4a Granite to quartz monzonite dikes; granitic pegmatite.

INTRUSIVE CONTACT

MAFIC INTRUSIVE ROCKS[3]

3a Metagabbro (garnet–clinopyroxene–amphibole–plagioclase gneiss).
3b Porphyritic metagabbro dike.

INTRUSIVE CONTACT (?)

FELSIC INTRUSIVE ROCKS[3]

2a Trondhjemite to granodiorite (?) dikes, fine grained to pegmatitic, granoblastic; intrudes gneissic rocks lit–par–lit.

INTRUSIVE CONTACT

GNEISSIC ROCKS

1a Garnet–biotite–clinopyroxene–amphibole–quartz–feldspar paragneiss, fine to medium grained, granoblastic.
1b Biotite–clinopyroxene–quartz–feldspar orthogneiss, fine to medium grained, granoblastic.
1c Amphibolite (clinopyroxene–amphibole–plagioclase)granoblastic; may represent sill–like intrusions or mafic volcanic rocks.

NOTES

1. Unconsolidated deposits.
2. Bedrock geology.
3. Age relationships difficult to establish.
4. These rocks do not outcrop; they were intersected in diamond drill holes of Pickands Mather Co. Descriptions are based upon petrographic examination of drill core by the author and drill logs of Pickands Mather Co.

Rock types in brackets are xenolithic in the preceding rock type.